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Organic Processed Food in Europe

Lisa Borghoff, Carola Strassner, Toralf Richter

With contributions from Nina Faiß, Lisa Hömmken and Damian Winter

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The role of organic processed food in food baskets, the role of processing technologies in the marketing of organic food and market trends in Europe for perception of processing technologies.

Lisa Borghoff[1], Carola Strassner[1], Toralf Richter[2]

With contributions from Nina Faiß[1] (Ch. 4.1), Lisa Hömmken[1] (Ch. 2.3), Damian Winter[1] (Ch. 2.2.4 & 4.1)

A ProOrg Report

Code of Practice for Organic Food Processing (ProOrg)

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CORE Organic is the acronym for "Coordination of European Transnational Research in Organic Food and Farming Systems". As an ERA-NET action, it intends to increase cooperation between national research activities. CORE Organic Cofund is the continuation of the ERA-Nets CORE Organic I, II and Plus. The CORE Organic Cofund consortium consists of 25 partners from 19 countries.

[1] FH Münster University of Applied Sciences
Department of Food – Nutrition – Facilities
Correns St. 25, D-48419 Münster, Germany
Lisa-Borghoff(at)fh-muenster.de, strassner(at)fh-muenster.de

[2] FiBL Research Institute of Organic Agriculture
Department of International Cooperation
Acker St. 113, CH-5070 Frick, Switzerland
toralf.richter(at)fibl.org

Executive Summary

While the organic food market is one of the fastest growing food sectors in the world with consistently increasing rates of growth in all advanced economies over the past ten years, a major and growing part of the organic food sold and consumed is transformed from harvested commodities by food processing into processed food products.

Differentiating between foods that are processed over and above food group categories remains a challenging issue. There are many classification systems for processed foods in academic literature and a few others applied in professional practice. Most of those designed with consumer nutrition guidance as one aim take nutrients or substances in general as their main criteria. Only the NOVA classification system takes processing techniques themselves into account. Furthermore, only the Wholefood Nutrition classification system (Vollwert Ernährung in Germany) takes environmental and additional impacts into consideration. Organic production itself is addressed by these two systems only: the former specifically excludes it while the latter specifically recommends food products from organic production. Thereby neither takes organic food processing itself into detailed account. Hence, neither these two nor any other of the described classification systems is appropriate for a deeper exploration of organic processed foods and a differentiation within these or between non-organic and organic processed foods.

It could be shown that organic foods in the market cover all categories within studied processed foods classifications, including very highly processed foods categories. Given the growing attention paid to processing of foods and their connection with human health, as well as the dietary recommendation made by several private and national nutrition bodies to avoid very highly processed foods, the organic sector does need to address this issue. One avenue could be to build on existing classification systems and adapt these to include organic specifications or else to develop a new classification, drawing on organic principles and the organic perspective as a guiding framework.

The legislation for organic processing of foods provides a general framework with guiding principles and permitted substances for processing; some few technologies are specifically mentioned and forbidden. The private standards of some organic associations provide more detailed guidance, though again, this is mostly limited to restriction of permitted substances and applications.

The organic sector finds itself in a dynamic growth phase in the European Union and elsewhere. This is not only limited to organic farming production but also includes organic food production. The market analysis could not distinguish between processed foods effectively or at all, but overall it underlines the growth in processed organic foods entering the market year on year. Trends in the data studied suggest an increase in very highly processed organic foods. This development needs to be referred to the overall guiding principles for organic food and farming and addressed by the sector. Communication of processing-related aspects of organic products as studied in producer websites, company video material and product packaging show little differentiation to that of non-organic products. Both would seem to use vague terms and avoid professional processing visuals. Herein may lie a chance for better promotion of organic foods if unique organic processing attributes can be distinguished.

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1. Introduction

While the organic food market is one of the fastest growing food sectors in the world with consistently increasing rates of growth in all advanced economies over the past ten years, a major and growing part of the organic food sold and consumed is transformed into products. This is based on processing technologies, transforming the harvested commodities into consumable products; hence the increasing demand of processed organic food represents a major challenge for the organic food industry.

In Europe, organic farming and production is regulated by Council Regulation (EC) No 834/2007 and from January 1, 2022 No 2018/848, defining the official EU aims, objectives and principles of organic farming and production, and by two implementing regulations (No 889/2008 and No 1235/2008) detailing the organic production, labelling and import rules. Except for a positive list of additives and technological aids, mandatory standards for the processing of organic food are lacking, nor are there indications that guide processors in the selection of appropriate technologies and innovations in line with the general principles of organic production and processing. To contribute to the sustainable innovation in the organic food sector, the project *Code of Practice for Organic Food Processing* (ProOrg) set itself the objective to develop a practicable Code of Practice for processors of organic foods as well as for labelling organizations. The Code aims to provide operators with strategies for making decisions that can help them to take the best choice for gentle processing methods or technologies and formulations free of artificial additives as well as sustainable packaging, while addressing the organic principles, high food quality, low environmental impact, and high degree of consumer acceptance. To labelling organisations the Code will provide an assessment and decision support tool to evaluate the compliance of new additives and processing technologies with the general organic principles. The Code aims to address activities in operations from raw material procurement, through processing technologies to consumer information.

The scientific partners of the project consortium are from Italy, Denmark, Germany, Netherlands, France, Poland, Switzerland, and Hungary. Stakeholder representatives are from the same countries and, in addition, from Norway, Bulgaria, Estonia, Latvia, Sweden and Slovakia. The project is organized in seven work packages; the afore-lying report is part of Work Package (WP) 5, i.e. the B2B Market Survey. The collection of market-related data and information bases on a comprehensive literature review, which is oriented to processing sector experts, organic processors, and retailers.

This report provides a basis for the B2B market survey conducted by the Research Institute of Organic Agriculture (FiBL). The development of the Code of Practice is part of WP2 under lead of the Association of Organic Food Processors (AOeL). The case studies in WP3 are conducted by the project partners from Wageningen University & Research (WUR). The assessment framework for estimating technologies is part of WP3 and conducted by FiBL. The project ProOrg also includes the consumer perspective on organic food processing and the communication between processors and consumers. This work is part of WP6 under lead of the Thünen Institute and subsequently Kassel University.

The field of food processing technologies is broad and extends from traditional technologies such as sun or oven drying to highly specialized ones that can only take place in a professional setting, such as high-pressure pasteurization (HPP). The range of possible processing technologies depends also on the product characteristics and therefore on the product type. For this reason, it has been necessary to focus on a limited range of products in the research project ProOrg. Characteristics of the

products chosen for further study include that they should be produced and consumed on a regular basis and in relevant amounts in the countries of the consortium, and that they should be available both in organic as well as in non-organic quality. The products should furthermore include plant-based as well as animal-based products. Meat was excluded because the main aim for this product group is the reduction of its consumption on account of the many negative environmental effects of meat consumption. Additionally, previous research on the foods and their processing technologies, a variety of processing technologies as well as at least one relatively new or innovative technology provide a good background. Considering these criteria, three products were selected as sample products for the project overall: drinking milk (cow), fruit juice and processed tomato products. All three products can be processed at different levels of specialization, in a private kitchen as well as in an industrialized setting. The basic principle of processing is heating to increase safety and durability, but these aims can also be reached by innovative processing methods working with pressure or electrical means. The results of the project's research can be transferred to other product types with similar processing aims and product characteristics.

This review covers the recent role of organic processed food in the organic food baskets and the role which different processing technologies play from a marketing point of view. Furthermore, market trends in Europe are compiled, which indicate the direction of preferred or accepted processing technologies from a processor, retailer, and consumer point of view. The main findings are presented on the following pages of this report. In Chapter 2 food processing differentiation as reported by academia and practice is presented. Chapter 3 particularises the legal requirements of organic food processing both at EU Regulation level and by selected private standards in Member States (pre-Brexit). Details are given in Annex A with an extensive set of tables. Chapter 4 explores the market for organic processed foods and Chapter 5 looks at communication of processing aspects by various channels. Chapter 6 brings the findings of this report together.

2. Classification of processed food

2.1 Differentiation of processed food in scientific research

While food processing has been a characteristic of human life for some centuries now, the technological development of the past decades has facilitated processing of a myriad of agricultural raw materials to an almost inexhaustible variety of manufactured food ingredients and formulations. This covers milling grains for flour to the production of a frozen meal, extracting oils or aromas for addition to the making of dairy or baked goods, to name a very few. This development in food processing has been accompanied by endeavours to differentiate between foods in some way, to sort and order processed foods. In this chapter we look at the way processed food is differentiated in academic texts and consider whether there are organic products available in each of the classification categories.

An initial literature review was carried out in July and August 2018 in several electronic data bases (Findex, Organic Eprints, Science direct, Google Scholar) using a focused set of term combinations ("food classification", "food classification system" "processing") in German and English. Most entries found were about the NOVA food classification system developed in Brazil in the late 2000s. Based on these findings, the NOVA food classification system was first compared with two classification systems most prominent in Germany, i.e. wholefood nutrition by Kollath and wholefood nutrition by von Koerber et al. (Gießener Vollwerternährung), culminating in a conference presentation and paper (Borghoff & Strassner 2019).

A second literature review was extended through a snowball system approach; literature disclosures from one article led to other articles and new classification systems. 25 articles were deemed relevant via the headline. Nine of them, with publication dates before the year 2000, could not be found. The remaining articles were checked on whether they included a classification system based on processing. Articles that classified food with an ethnological approach (foods and taboos) were excluded. Of the selected articles, nine food classification systems classify food via their stage of processing in general, and eight classification systems focus on the grade of convenience a product has through processing. Also, two classification systems by national organizations for identifying single food products were considered, because these use information on processing for identification.

2.1.1 Food classification systems based on processing stages

Wholefood nutrition by Kollath (1941)

Werner Kollath developed his food classification system based on the writings of Bircher-Benner and on animal experiments. In 1941 he published his research in his main work "Die Ordnung unserer Nahrung" (own translation: The order of our food), which was edited for the last time in 1960. Newer editions are featured with commentaries about actual research findings. Kollath distinguishes six stages with increasing degrees of processing and decreasing value in parallel and presents these in tabular form (see Table 1). He justifies this evaluation in his book with the decreasing content of so-called vital substances due to processing but takes into account the better bioavailability of individual nutrients after processing. Kollath recommends eating mainly of the products of the first four value levels. Jam, for example, is conserved food in this classification (stage 5), white flour noodles are prepared food (stage 6). Thus, organic food equivalents can also be found in these value stages. A direct reference to organic food is neither found in Kollath's writing nor in the nutrition table. However,

he describes the importance of a soil-preserving primary production for the health effect of a food and calls for a resource-saving technical use. Also, food is classified via its origin in plant and animal-based food. Plant-based foods are ranked higher than animal-based foods in the table. In his book, Kollath claims whole fresh milk and grains as the optimal food products for human health. The combination of these products can be found in the so-called “Kollath-Frühstück”, a breakfast mixture of mashed fresh grains and milk that can be enhanced with nuts and fresh fruits. (Kollath 2005)

Table 1 Classification of foods in wholefood nutrition by Kollath (own table, shortened and translated, based on Kollath 2005, pp.34-35)

	Food (“alive”), agency of change			Food (“dead”), agency of change		
	unchanged	**mechanical**	**fermentative**	**heated**	**conserved**	**prepared**
plant	nuts	oil	soy	-	white bread	margarine, starch, sugar
	cereals	flour, bruised grain	mush	whole grain bread	rusk	
	fruits	salads I	fermented juice	legumes	canned fruit	fructose, aroma, vitamins
	vegetables	salads II	fermented vegetables	potatoes	canned vegetables	
animal	eggs	blood	meat	wild meat, fish	canned meat	extracts from meat
	milk	dairy products	fermented milk	cooked milk	canned dairy products	milk protein, lactose
beverages	spring water	tap water	wine, beer	tea, broth	mixed drinks	distillates

Wholefood Nutrition by von Koerber et al. (Gießener Vollwerternährung) (1981)

This food classification system by von Koerber et al. is a later development based on Kollath’s table of foods and therefore follows directly after Kollath’s system. It was first published in 1981, the last edited version is from 2004. The whole-food dietary regimen aims to consider food holistically. In this diet, food should be as ecologically, regionally, seasonally, and fair as possible, which is not explicitly mentioned in the table of foods given as orientation (see Table 2). The classification system comprises four (in the past five) stages of value. According to the authors, a healthy diet should be based on products of the stages one and two in equal parts. Some products of this level, e.g. honey should be consumed only moderately. More highly processed food should be eaten rarely because it is often nutritionally unfavourable and may contain questionable additives. Examples of these products are nut nougat creams or soy meat. Such products are also available in organic quality. Besides the stage of processing, foods are also classified by their product group. Wholefood nutrition by von Koerber et al. favours a diet with low or no consumption of meat. The effects of such a diet on health have been studied during the 1990s. The assessment of nutrient supply according to the guidelines of the German nutrition society (DGE) was positive. (von Koerber et al. 2004)

Table 2 Wholefood nutrition by von Koerber et al. (Gießener Vollwerternährung) (own, shortened, added, and translated table, based on von Koerber et al. 2004, pp. 190-191)

	Very recommendable	Very recommendable	Less recommendable	Not recommendable
food group	not or minimally processed, not heated	moderately processed, mostly heated	highly processed, mostly conserved	extreme processed, supplements, isolates
fruits, vegetables	fresh fruits and vegetables	heated or frozen fruits and vegetables	canned fruits and vegetables	complete frozen dishes
cereals	fresh whole grain flakes	whole grain products	white grain products	cereal starch
potatoes	-	cooked potatoes	French fries	potato starch
legumes	-	cooked legumes	soy milk, tofu	soy meat
nuts, fats, oils	nuts, almonds, olives	roasted nuts, oil, butter	refined oils	sweetened hazelnut cocoa cream
milk and dairy products	raw drinking milk	pasteurized full fat milk	ultra-high temperature (UHT) milk	condensed milk
meat, fish, eggs	-	meat, fish, eggs	canned products	offal, egg powder
beverages	natural mineral water	tea, fruit juices thinned with water	table water, coffee	lemonade
spices, herbs, salt	fresh herbs	dried herbs	kitchen salt	aroma
sweeteners	fresh fruits	honey, dried fruits	syrup, natural brown sugar	artificial sweeteners, sucrose
processing methods used		*heating, freezing of single ingredients, cooking, roasting, pasteurization, thinning (beverages) drying*	*conserving, canning, extracting (grain) by grinding, deep-frying, cooking (soymilk), denaturation (tofu), refining (oils, sugar), UHT treating (milk)*	*isolating (starch), supplementing, freezing (complete dishes), sweetening, condensation (milk), addition of additives and flavouring*

Supplements, with the exception of iodized salt, should not be part of this diet, because the diet itself, according to its proponents, should contain all nutrients that are needed for a healthy living. Considering milk, the most recommended milk types are raw or pasteurized milk while UHT milk is less recommendable.

International Food Policy and Research Institute (IFPRI) classification system (2009)

This food classification system based on food processing was developed by the International Food Policy and Research Institute (IFPRI) and has been used for research about food consumption in Guatemala (Asfaw 2011). The IFPRI food classification system classifies foods only by their stage of processing while the product group is not included in the classification. Three processing stages are differentiated (see Table 3 below). Unprocessed products include foods that can be eaten raw (such as fresh fruits) while others should be prepared in some way (such as meat or beans) before consumption.

Table 3 IFPRI classification system (own table with additions, based on Aswaf 2009, p. 186)

Food groups	items	*used processing methods*
Unprocessed	corn (staple), other grains, roots, tubers, vegetables, fruits, meat, fish, eggs, beans, dairy (fresh, dried, mild, cream)	*drying*
Partially processed	corn products (including tortillas), other flours and processed grains, dairy products (evaporated milk, cheese, yogurt), animal fats (lard, butter), vegetable oils, sugars and sweeteners, bread	*grinding and processing (grains), evaporating (milk, cheese, yoghurt), pressing (oil), refining (sugar)*
Highly processed	pastries, cookies and crackers, ice cream and frozen desserts, confectionary (sweets, chocolates), pasta products, prepared meals (e.g. dried soup), sausages and prepared meats, breakfast cereals, fat spreads and shortening, soft drinks (e.g. packaged juices), formula and complementary foods)	*industrial formulations, prepared mixtures and meals*

The food group “highly processed” includes products that are mostly industrially processed such as soft drinks or dried soup. The classification system does not take issue with the place of preparation whether at home or in the food industry. As in the systems before, matching organic examples can be found in every group.

International Agency for Research on Cancer (IARC) EPIC system (2009)

This European food classification system by the International Agency for Research on Cancer was first published in 2009 and again in 2011 (Moubarac et al. 2014; p. 262; Slimani et al. 2009). It is part of the repertoire used in the longitudinal cohort study, the European Prospective Investigation into Cancer and Nutrition (EPIC). Again, food is only classified by its stage of processing into three groups with four sub-groups (see Table 4).

Table 4 IARC-EPIC food classification system (own table with additions, based on Moubarac et al. 2014, p. 262)

Foods groups	Definition	Examples	*Used processing methods*
1 Non-processed	Foods consumed raw without any further processing, preparation, except washing, cutting, squeezing	Raw fruits, non-processed nuts, raw fresh vegetables, fresh juices	*Washing, cutting, squeezing, drying (nuts, seeds, fruits), canning*
2 Modestly or moderately processed	2.1: Industrial and commercial foods involving relatively modest processing and consumed with no further cooking	2.1: Dried fruits, nuts and seeds, fruits and vegetables canned in water, green and chamomile tea	
	2.2: Foods processed at home and prepared /cooked from raw or moderately processed foods	2.2: Fresh or frozen cooked vegetables, whole meal boiled rice, whole cooked egg	
3 Processed	Foods industrially prepared involving a high degree of processing such as drying, flaking, hydrogenation, heat treatment, use of industrial ingredients and industrial deep frying	3.1: Processed staple / basic: bread, pasta, rice, milk, butter 3.2: Highly processed: cakes, biscuits, breakfast cereals	*Drying, flaking, hydrogenating, heat treatment, use of industrial ingredients, deep frying*

There is a differentiation between food that has been prepared at home (Group 2.2) and industrially processed (Group 2.1 and Group 3). The processed food group 3.1 includes a lot of food that is part of the daily diet in Germany, such as bread (MRI 2008). Organic counterparts can be found across all categories.

International Food and Information Council (IFIC) classification (2010)

The International Food and Information Council (IFIC) developed a classification system for processed food that Eicher-Miller et al. (2012) used for analysing which contribution processed food gives to nutrient intake in the US diet (IFIC 2010). Eicher-Miller et al. (2012) assert that food processing and especially food enrichment with critical nutrients (e.g. iodine) have had a positive effect on the health status of the U.S. population. Every class of the classification system encompasses a wide variety of foods and in every category; the authors claim that foods with negative or positive effects on human health can be found across all these (see Table 5). Accordingly, the authors do not include a connection between the stage of processing and health effects, and they also do not include stages of processing into dietary recommendations. For a healthy diet, the authors maintain that the food's nutrient composition and the frequency of eating are more important. (Eicher-Miller et al. 2012) The results of this research are contrary to the research results of Monteiro et al. (see NOVA food classification system below).

Table 5 IFIC classification system (own table with additions, based on Eicher-Miller et al. 2012, p. 2066S)

Stage of processing	Description	Example	*Used processing methods*
minimally processed	foods that retain most of their inherent properties	washed and packaged fruits and vegetables; roasted nuts	*washing, packaging, roasting*
foods processed for preservation	nutrient enhancement and freshness	canned tuna and beans, frozen fruits and vegetables	*canning, freezing*
mixtures of combined ingredients	food containing sweeteners, spices, oils, colours, flavours, and preservatives used for the purpose of promoting safety, taste, and visual appeal	cake mix, jarred tomato sauce, salad dressing, rice	*mixing, combining*
ready-to-eat processed foods		breakfast cereal, cracker, ice cream, yoghurt, luncheon meats, fruit drinks, carbonated beverages	*carbonating*
prepared foods / meals	foods packaged for freshness and ease of preparation	frozen dinners and entrées, prepared deli foods	*freezing (complete dish), completely prepared*

The classification system itself categorizes foods only regarding their stage of processing by means of five categories. Minimally processed foods are described as those whereby the processing does not change the inherent properties of the food. Additives are mentioned in the category "mixtures of

combined ingredients" and their purposes range from preservation of the food to influencing the taste and visual appeal. Again, across all categories matching organic examples can be found.

The Food Standard Australia New Zealand (FSANZ) (2014)

This classification system separates food only into the categories "unprocessed" and "processed" (see Table 6), based on the risk of contamination and other hygienic problems that come into account with food (FSANZ 2014).

Table 6 FSANZ (own, shortened table, based on Crino et al. 2017, pp. 7-10)

Unprocessed (examples)	Processed (examples)
fresh, canned, or prepared fruits and vegetables, chilled fish or seafood, honey, meat	bread, breakfast cereals, chilled noodles and pizza, chilled ready meals, dehydrated soups

Food Classification System by Poti & Mendez (2015)

This classification system was developed for analysing US consumer data about food and beverages. Foods are classified into the groups unprocessed or minimally processed, processed basic, moderately processed, and highly processed with several subgroups (see Table 7). In the same way as in the IFIC classification system, minimally processed food has undergone only processing that did not change its inner properties. For highly processed products the origin of the product is not recognizable anymore. Also, these food groups are characterized by their industrial processing. (Poti et al. 2015)

Table 7 Classification System by Poti & Mendez (own table, shortened and with additions, based on Poti et al. 2015)

Category / definition	Beverages	Fruit, vegetables, legumes	Meat/meat dishes, eggs	Grain products	Dairy products	Fats/oils, sweets, other	*Used processing method*
Unprocessed / minimally processed: *single-ingredient foods with no or very slight modifications that do not change inherent properties of the food as found in its natural form*	fresh plain milk, coffee from beans, tea, water	fresh, frozen, dried plain fruits, vegetables, and legumes	eggs, unseasoned meat	whole grain plain hot cereal, brown rice	cream	honey, herbs, spices, pepper	
Processed basic ingredients: *single isolated food components obtained by extraction or purification using physical or chemical processes that change inherent properties of the food*	unsweetened fruit juice not made from concentrate	-	egg whites	wholegrain flour and pasta	-	oil, unsalted butter, sugar, pure maple syrup, salt	*extraction, purification, changing inherent properties of the food*
Processed for basic preservation or precooking: *single minimally processed foods modified by physical or chemical processes for preservation or*	unsweetened fruit juice from concentrate, dry	Unsweetened / unflavoured canned fruit, vegetables, or legumes; pure peanut	unseasoned canned meat	refined-grain pasta or flour, white rice, instant rice	sour cream, plain yoghurt,	-	*preservation, precooking*

precooking but remaining as single foods	milk, instant coffee	butter (no added sugar or salt)			evaporated milk		
Moderately processed for flavour: *single minimally or moderately processed foods with addition of flavour additives for the purpose of enhancing flavour; directly recognizable as original plant / animal source*	sweetened/flavoured fruit or vegetable juice, tea, soy milk; chocolate or cocoa mix	sweetened/flavoured canned, dried, refrigerated or frozen fruit, vegetables, legumes; potato chips; frozen French fries; salted peanut butter, nuts with salt or oil	seasoned, refrigerated, frozen, canned meat; smoked or cured bacon, ham or sea food	sweetened, flavoured hot cereal; flavoured pasta or popcorn	cheese; sweetened/ flavoured yoghurt; sweetened condensed milk, whipped cream	salted butter, flavoured oil, seasoning salt	*addition of additives (flavouring), sweetening, canning, drying, refrigeration, freezing, deep-frying, seasoning, smoking, curing, condensation (milk)*
Moderately processed grain products: *grain products made from whole-grain flour with water, salt, and/or yeast*	-	-	-	whole-grain breads, tortillas, crackers, RTE* cereals with no added sugar or fat	-	-	
Highly processed ingredients: *multi-ingredient industrially formulated mixtures processed to the extent that they are no longer recognizable as their original plant/animal source and consumed as additions*	-	tomato sauce, hummus, salsa, jelly	-	bread crumbs, breading with refined grains or added fat/sugar	creamer, whipped topping, dips, Alfredo sauce	margarine, mayonnaise, salad dressing, artificial sweetener, ketchup, sauce/seasoning mixes	*industrial formulations, processing, to the extent that mixtures are no longer recognizable as their original source, breading with refined grains or added fat/sugar, flavouring, conserving, canning*
Highly processed stand-alone: *multi-ingredient industrially formulated mixtures processed to the extent that they are no longer recognizable as their original plant/animal source and not typically consumed as additions*	soda, alcohol, fruit/ sports/ energy drinks, flavoured waters, coffee beverages	fruit snacks, chocolate/yoghurt covered fruits/nuts; vegetable soups, frozen vegetables in sauce; instant potato dishes	sausages, hot dogs; spam; breaded meat, meat-based frozen meals	bread, tortillas, rolls, bagels, RTE breakfast cereals, pancakes, waffles, frozen pizza, canned pasta	ice cream, frozen yoghurt, pudding, processed cheese	candy, chocolate, popsicles, broth, bouillon	

*RTE=ready to eat

NOVA food classification system (2010)

Considering the low importance of food processing in current dietary recommendations, Monteiro and colleagues developed the NOVA food classification system at the University of São Paulo in Brazil and first published it in 2010. This system does not focus on nutrients or individual foods, but product groups based on their processing. It comprises four (previously three) levels of value (see Table 8). The basis of a diet are level 1 foods, prepared with level 2 products and supplemented with limited

quantities of level 3 products. Level 4 products should be eaten rarely, because they have a negative impact on health, culture, social life, and the environment according to the authors. They cannot be called "real food" (Monteiro et al. 2012, S. 531-532). This is reminiscent of Kollath, where food was separated into “living” food and “dead” food, for which Kollath used the German words “Lebensmittel” and “Nahrungsmittel” respectively. In the same way as for the systems before, foods from all groups can be found in organic quality. The influence of the agricultural method on the nutritional content and taste of the food is recognized by NOVA, but it is deliberately not included in the classification system to keep it as simple as possible. (Monteiro et al. 2010, 2012, 2016; Moubarac et al. 2014).

Table 8 NOVA food classification system (own shortened table with additions, based on Monteiro et al. 2016, pp. 31-33)

Groups	Definition	Examples	*Used processing methods*
1: un- or minimally processed food	Natural foods altered by processing such as removal of inedible parts; no adding of substances, except of vitamins and minerals that got lost due to processing or additives that preserve the properties of the original food; main purpose of processing is to extend the life of the product, facilitating or diversifying food preparation	fresh, frozen, dried fruits and vegetables, legumes, cereals, parboiled or white rice, fresh or pasteurized juice, eggs, pasteurized powdered milk, oats, plain yoghurt, vacuum-packed vegetables, ultra-pasteurized milk	*addition of additives, which got lost due to processing or preserve the properties of original food, freezing, drying, parboiling (rice), husking (rice), pasteurization, powdering (milk), vacuum-packing, UHT treating (milk)*
2: processed culinary ingredients	Substances obtained directly from group 1 foods or from nature by processing such as pressing, refining, milling and spray drying; are used to prepare foods from group 1; normally not consumed without foods from group 1; may contain additives used to preserve the product’s original properties	salt, sugar, honey, butter, oils	*Group 1+ pressing, refining, milling, spray drying, addition of additives (preserving)*
3: processed foods	Relatively simple products made from foods from group 1 and 2; most have two or three ingredients; processing is done to increase the durability of group 1 foods or to modify or enhance their sensory qualities; may contain additives used to preserve their original properties or to resist microbial contamination	fruits in syrup, canned or bottled vegetables, fruits, and legumes; canned fish; cheeses; unpackaged fresh daily bread; salted or sugared nuts	*Group 1 and 2 + canning, salting, sugaring*
4: ultra-processed foods	Industrial formulations typically with five or more ingredients; only in this group we can find substances not commonly used in culinary preparations and additives that imitate or disguise flavour; are often ready to eat, drink or heat, hyper-palatable, attractive packaging, aggressive marketing, health claims	carbonated drinks, packaged snacks, energy drinks, fruit yoghurts, prepared dishes, cookies, margarines	*addition of additives, flavouring for imitation or disguising, carbonating, preparing;* *aggressive marketing, health claiming*

The NOVA food classification system includes not only nutritional aspects of food products, but also their marketing. Ultra-processed products (UPP) have as characteristics both the aggressive marketing and the industrial processing. This is the same as for the highly processed products by Poti and Mendez. It should be highlighted that additives are not excluded in general. It depends on their purpose whether they are acceptable in the highly recommendable group 1 or in group 4. According to the classification system it is acceptable to use additives to preserve the properties of the original food or add vitamins and minerals that are lost during processing. When additives are used to hide a lower quality of the product, the food is allocated into group 4.

Food Classification System by Niggemeier and Schmid, based on NOVA (2016)

Claudia Niggemeier and Almut Schmid, two nutrition scientists from the University of Paderborn in Germany, developed a food classification system for research application due to lack of an internationally recognized uniform system. The basis for their system was the NOVA food classification system, which they completed with more subclasses in each category (see Table 9). The final system was adapted to a typical German diet. (Niggemeier & Schmid 2016) The group “unprocessed or minimally processed food” here is named “fresh food” and includes the class “processed culinary ingredients”. Using milk as an example, it can be seen how the treatment of the product leads to a different classification. Thus, fresh or pasteurized milk is classified into group 1 while UHT milk is classified as group 2. Interestingly, only the heat treatment of the milk is considered while homogenization does not seem to have an impact on the category allocation of milk. The category of highly processed products includes products such as jam, which can be industrially produced or made at household level. Products across all categories can again be found as equivalents in the organic food market.

Table 9 Classification system by Niggemeier and Schmid (own table with additions, based on Niggemeier & Schmid 2016, p. 207)

Food product classified by grade of processing		examples	Nr.	*Used processing methods*
Fresh food		fruit, vegetable, nuts, roots, frozen unprocessed food, dry fruit, raw meat and fish, rice, potato, unsweetened fruit juice, cereals, water, tea, eggs, fresh or pasteurized milk, cream, fermented cream products, fresh cheese	1	*freezing, drying, pasteurization, fermentation*
		UHT milk and dairy products, condensed milk, fat reduced natural yoghurt, coffee cream	2	*UHT treating (milk)*
		fat, native oils, flour, sugar, salt, butter, raw/fresh pasta, vinegar, herbs, pure spice, soy sauce, baking agent, vanillin, honey, coffee, mustard, yeast, cocoa	3	
		hydrogenated fat and oil, margarine, half-fat butter	4	*hydrogenating*
Processed food		canned fruit and vegetable, ham, smoked fish, cured meat, ripened cheese, canned fish with oil, non-packaged bread, fruit nectar, flavoured yoghurt, fresh cheese compositions, frozen vegetable with butter, packaged salad, candy fruit, flavoured curd	5	*canning, smoking, curing, ripening, flavouring, freezing (of mixture)*
		puffed or boiled cereal, muesli mixture	6	*puffing, boiling, mixing*
		beer with and without alcohol, wine, liquors,	7	*brewing*
Highly processed food	Ready-to-eat	desserts, cereal bars, cookies, cakes, pasties, ice cream, jam, sweets, chocolate, crisps, whipped cream, flavoured cheese, processed cheese, cheese analogue, packaged bread, syrup, compote, raw sausages, cooked sausages, ketchup, remoulade, tomato sauce, Wurst salad	8	*whipping, flavouring, "processing" (cheese), cooking (sausages)*
		hamburger, hot dogs, doner kebab, currywurst	9	
		sweetened / coloured / cooked cereals, flavoured and/or extruded cereals	10	*sweetening, colouring, cooking (cereals), flavouring, extruding*
		Infant / baby formula	11	
	Ready-to-heat	processed meat, pasta dishes (also frozen), rice dishes, sausages, chicken nuggets, canned soup, ready-made sauces, camembert, crumbed fish, fish finger, frozen bakery products, ravioli	12	*processing (meat), canning, crumbing (fish), freezing (bakery products)*
		pizza, lasagne, tarte flambée	13	
		potato dishes, chips, dried potato products	14	*drying*
	Adding liquids	dried soup, dried products (except dried potato products), spice mix, concentrates, flavoured mixed herbs, soluble tea, fruit purée, baking mixes, instant coffee	15	
		instant formula	16	
		soft drinks, lemonade, sweetened milk drinks, sweetened fruit juices, milk shakes	17	

2.1.2 Food classification systems based on the grade of convenience

Systems used for supermarket analysis by Livingston and Chang (1978)

Livingston and Chang use several classes to divide food in their analyses. One classification system works first with the product group and in a second step the kind of processing is described, for example canned or dried fruits. However, not every product group is further described by the processing method, e.g. for nuts, they do not describe if these are fresh or dried and salted.

For high convenience food, they differentiate products between ready-to-eat at home or ready-to-eat away from home, ready-to-heat, ready-to-cook and all other foods.

For frozen foods, they use the classes prepared foods, fish and seafood, vegetables, poultry, meat, juice, and fruit. Also, they differentiate between prepared and raw frozen food, but they do not combine these categories with the one before.

The group prepared meals is broken down further to these sub-groups: complete meals, main dishes, breaded poultry, pizza, seafood specialty, snacks, desserts, bakery products, prepared vegetables, nationality foods, breakfast items, vegetable creams and miscellaneous.

Convenience foods are categorized by their form: fresh, frozen, freeze-dried, dry-mix, dry (not mixed), canned. (Livingston & Chang 1978)

Food Classification System by Paulus (1978)

Paulus developed a system based on the grade of readiness depending on the technological treatment to which the product had been exposed (see Table 10). He also describes what processing methods are needed before eating. (Paulus 1978, p. 7-9)

Table 10 Classification system by Paulus (own table, shortened, based on Paulus 1978, p. 8)

Phase and designation	explanation	example	Processing required
1: ready to process	processing needed	carcass halves	cutting of the meat, preparation
2: ready to kitchen process	suitable for kitchen processing	vegetables, potatoes, cuts of meat, powders, flour	preparation, dimensioning, recipe, cooking, portioning
3: ready to cook	suitable for direct cooking	peeled potatoes, portioned meat	cooking, portioning, if necessary
4: ready to heat	suitable for heating to eating temperature	ready-to-serve foods (single items or complete menus)	final cooking/heating to eating temperature, portioning, if necessary
5: ready to eat	suitable for direct consumption	hot meals from central kitchen; bread, baked goods, desserts, beverages	portioning, if necessary

Food Classification System by Harrison (1979)

The classification system by Harrison (see Table 11) is based on the stage of convenience the product has and is oriented to the consumer. He does not describe the processing methods needed before consumption as Paulus did. (Harrison 1979)

Table 11 Classification system for convenience food by Harrison (own table, based on Costa et al. 2001, p. 234)

Convenience Scale	Description
Zero convenience	completely fresh produce; the unprocessed product where the requirement for peeling, paring, maturing, cleaning, basic preparation, and other basic stages must be done.
Basic convenience	Where basic stages as described have been completed but where slicing, shredding, mincing, soaking, dicing, chopping, rolling, shaping, etc. must be carried out.
Pre-assembly convenience	Where items mentioned above have been carried out, but the aspect of assembly is missing; constituents are available in an easy to handle format but need to be combined.
Pre-cooking convenience	Where the items or principal constituents are assembled prior to cooking.
Pre-service convenience	Where items have minimal processing prior to service and where only defrosting or/and end-cooking or similar activities are required before service.
Full-service convenience	Where items are ready to serve, when nothing more than opening a can or box is required.

Food Classification System by Pepper (1980)

Pepper proposed a classification system for convenience food based on the processing methods that are needed before consuming the products. Class 1 products can be consumed directly, while class 5 products need to be heated before eating (see Table 12). The grade of processing that is needed rises from Class 1 to Class 5. (Pepper 1980, p. 254)

Table 12 Classification system by Pepper (own table, based on Pepper 1980, p. 254)

Required processing method		Class
(a)	No preparation	C1
(b)	Mixing	C2
(c)	Heating	C3
(d)	Mixing and cooking	C4
(e)	Cooking	C5

Food Classification System by Havlicek, Axelson, Capps, Pearson & Richardson (1983)

This system has been developed based on the work by Traub and Odland (1979) and focuses on the grade of convenience the food has reached through the processing method (see Table 13).

Table 13 System by Havlicek et al. (1983) (own table, based on Pearson et al. 1985, pp. 133-134)

Class		Description
1	Non convenience	Fresh, unprocessed food; home frozen, home canned, home pre-served, ingredient foods (processed food products used in food preparation that cannot be commonly prepared at home)
2	Basic convenience	Single ingredient processed items
3	Complex convenience	Multi-ingredient processed mixtures; high level of time saving and culinary skill
4	Manufactured convenience	Products that have no home-prepared counterparts

This system shows a similarity between ingredient foods with the Group 2 foods "processed culinary ingredients" and between Class 4 "manufactured convenience" and the Group 4 ultra-processed products of the NOVA classification system.

Food Classification System by Pearson et al. (1985)

The system by Pearson et al. food is classified in a two-sided matrix (see Table 14). The food is classified via the processing method that is still needed and if it is a convenience food or not. (Pearson et al. 1985)

Table 14 Classification system by Pearson et al. (own, shortened table based on Costa et al. 2001, p. 235)

	Non-Convenience	Convenience
No Preparation (Eat as is, ready to use)	*Food is inserted here; no examples given*	
Some Preparation (Cut, slice and shell, ready to heat, ready to cook, etc.)		
Considerable Preparation (Cut, peel then cook; add other ingredients, then cook; eviscerate, prepare for cooking, then cook)		

Food Classification System by Costa et al. (2001)

The system developed by Costa and colleagues combines the preparation methods needed before eating the home meal replacement with the shelf life of the product, again combined in a two-sided matrix (see Table 15). (Costa et al. 2001)

Table 15 Classification of home meal replacements by Costa et al. (own table based on Costa et al. 2001, p. 237)

	C1 (ready to eat)	C2 (ready to heat)	C3 (ready to end-cook)	C4 (ready to cook)
S1 (shelf-life <1.5 weeks)		*Food is inserted here*		
S2 (1.5weeks≤shelf-life<1.5 months)				
S3 (1.5months≤shelf-life<1.5 years)				
S4 (shelf-life≥1.5 years)				

Food Classification System by van der Horst et al. (2011)

For their research on the association between ready-meal consumption, weight status and cooking skills, Klazine van der Horst, Thomas Brunner and Michael Siegrist developed a classification system for convenience food. They use four classes that describe the grade of processing a product has gone through (see Table 16). Cut and washed salads are in an extra class.

Table 16 Food classification system by van der Horst et al. (own table based on van der Horst et al. 2010, p. 240)

Class	Example
Highly processed food items	Ready meals
Moderately processed food items	Sandwich, chilled or frozen pizza
Single components	Crumbed meat
Salads	Cut and washed salad

Ready meals are further classified by the way of their preparation (see Table 17 below).

Table 17 Ready meal classification by van der Horst et al. (own table based on van der Horst et al 2010, p. 241)

	Preparation of the ready meals
i	Ready meals in a can (ravioli, chili con carne, etc.)
ii	Ready meals chilled / frozen (lasagne, nasi-goreng, etc.)
iii	Instant noodles, soup or paste (in a cup for one person)
iv	Instant pasta with sauce (dried, add water, cook)
v	Ready soup in bag or can
vi	Ready pizza chilled / frozen

2.1.3 Food classification systems underlying food identification

AUSNUT (AUStralian Food and NUTrient Database) System

In this numerical system, foods are differentiated in a major group (two-digit), a sub-major group (three-digit) and a minor group (five-digit). The major group describes the main ingredients of the food, e.g. cereal and cereal products. The sub-major group describes in more detail the type of food, e.g. regular bread. The minor group describes nutritional or manufacturing factors, e.g. bread roll from white flour. Every product is classified by all three categories and digits are allocated for each group (see the example in Table 18). These digits together form the survey ID of the product. (O'Halloran et al. 2017) AUSNUT is a specific system for national nutrition surveys.

Table 18 Bread rolls in the AUSNUT food group classification (own table, based on O'Halloran et al. 2017)

1	2	3	4
Major food category: two-digit food code	Sub-major food category: three-digit food code	Minor food category: five-digit food code	Survey ID: eight-digit food code
12 Cereal and Cereal Products	122 Regular bread and bread rolls	12201 White bread and bread rolls	12201013 Bread roll from white flour

The German Nutrient Data Base (Bundeslebensmittelschluessel)

The Bundeslebensmittelschluessel (BLS) system was developed for nutrition assessment surveys in Germany. It uses a seven-digit system, similar to the AUSNUT classification system for identification of foods. The first four digits classify food by a main group, sub-group, and the exact kind of product. The fifth and sixth digits describe the type of processing the food has undergone and if it is designed for household use, large-scale catering, or gastronomy. (Hartmann, Grotz & Stang 2010, pp. 7-12). Table 19 illustrates the BLS with the example of canned peaches across the 7-digit-system (1-4: product type, 5: industrial processing, 6: processing at home; 7: weight).

Table 19 Canned Peach in BLS (own table based on Hartmann, Grotz & Stang 2010)

1	2	3	4	5	6a	6b	7
Main Group	Sub-Group	Single food product	Single food product	Type of processing or specification	Preparation, cooking process	Household, large-scale catering, gastronomy	Reference weight
fruits	2 Stone fruit	03 peach	111 fresh	9 industrially processed: canned	0 standard	0 standard	2 drained

2.2 Categories of processed foods used in practice

In contrast to the previous section focusing on food processing or processed foods classification systems in academic texts, this section explores categories and classification systems used in practical applications. 'Practice' here loosely refers to e.g. food processors, retailers, catering, consumers. Research was similarly based on a literature search, with the same databases and key words as for Section 2.1, but the results were judged on whether they had a practical approach or not. Additionally, experts in the field of catering were contacted. The publishing company Jam-Verlag in Ratingen (Germany) publishes trade journals for catering, canteens, and restaurants. The organic food association Bioland e.V. has own experts for hotels, restaurants, and catering (horeca). Neither could add additional category systems to the categories of processed food in current practice presented below.

2.2.1 Classification systems used in catering

The systems described in literature for application in catering service contexts are very similar to each other. Berghofer et al. (2017) describe a system based on the grade of convenience the product has (see Table 20). Thereby, the higher the convenience grade is, the less processing steps need to be undertaken by the consumer. With a higher grade of convenience, the durability of a product or meal is reduced. To extend the shelf life of products of a high convenience grade, preservation methods have to be used. (Berghofer 2007, pp.10-11) It follows that products from a low convenience grade are less processed than products from a high convenience grade.

Table 20 Convenience grade (own table, based on Berghofer 2007, p. 11)

Convenience Grade	Example
Initial grade	Cereals, fruits and vegetables, potatoes, animal carcass halves
Ready for kitchen processing	Flour; washed, sliced vegetables; washed, selected potatoes; sliced meat
Ready to cook	Pieces of dough; raw frozen vegetables; peeled potatoes; frozen fish fingers
Ready to mix	Instant noodles; cooked, freeze-dried vegetables; potato mash powder; milk powder; cooked, freeze-dried meat products; all instant products
Ready to heat, heat and eat	Precooked dough products; frozen baking products; wet canned vegetables; peeled, cooked potatoes; cooked meat; conserved ready meals (single components, full menus)
Ready to eat	Bread and baking products; pickles; crisps; sausages, cheese; warm meals from catering services or canteens

The German Federal Centre for Nutrition (Bundeszentrum für Ernährung (BzfE)) presents a similar system on their website, except that Berghofer uses one more class for raw unprocessed products. Both authors give different examples for the categories. The five grades of convenience of the German Federal Centre for Nutrition are illustrated in Table 21.

Table 21 The 5 grades of convenience (own table based on Bundeszentrum für Ernährung 2018)

Convenience grade	Processing that is still needed	Example
1 Kitchen ready	Seasoning, portioning, breading	Pre-cleaned vegetables, sliced meat
2 Ready to cook	Cooking without further preparation	Pasta; frozen vegetables; breaded, seasoned meat
3 Ready to mix	Mixing with other products is needed to create a complete product	Dried salad dressing; pudding powder; instant soups
4 Ready to heat	Product must be heated up before consuming	Ready meals or single meal components
5 Ready to eat	Product can be consumed without any preparation	Cold sauces, full prepared salads, smoothies, canned fruit

The system that Schwarz (2019) presents, is used by caterers and restaurateurs to plan the meals and the way the professional kitchen is designed. Thus, depending on the convenience grade that is used in the kitchen, different kitchen planning is needed.

Table 22 Convenience level for out-of-home industry (own table, based on Schwarz 2019, p. 71)

Convenience Grade	Description	Work that has flown into the product / readiness
C0 Basic level	Fresh or raw product	5-10%
C1 Kitchen ready	Products are partly processed	20-30%
C2 Ready for preparation	Products can be used without further preparation	40-60%
C3 Ready for reworking	Products are almost ready	70-80%
C4 Ready to eat	Products can be given to the consumer without further preparation	90-100%

Hersener (2015) describes how a product goes through the stages of convenience. In contrast to Berghofer and Schwarz (see above), only four stages are used. By looking at the first stage as presented in Table 23, we can see that within the first stage some work has already flown into the product (washing of the raw potatoes). This is similar to the system of the German Federal Centre for Nutrition (BzfE). Both systems do not start with a complete unprocessed product.

Table 23 From potato to French fries (own table, based on Hersener 2015, p.30)

Stage of convenience	Example: from potato to French fries
1 Partly processed product	Raw washed potatoes
2 Ready to cook	Peeled, sliced potatoes
3 Prepared products	Pre-blanched French fries
4 The product itself	French fries

Hamatschek (2016) describes a dichotomous classification system of processed food (see Table 24). Differencing from the systems before, these categories are not made mainly for catering, but aim at the food processing sector. Products from the first level of processing do not get added to by other substances like unprocessed products from the NOVA food classification system. The technology used for food production can be artisanal or industrial.

Table 24 Stages of processing (own table, based on Hamatschek 2016, pp. 20-21)

Stage of processing	Products	Processing methods
Frist stage of processing	Raw agricultural products; no substantial change of the product through processing Products of this stage have only a short lifetime and need to be stored cool often Can be consumed directly or need to be heated Examples: Fresh milk, meat, vegetables	Splitting, separating, peeling, milling, freezing, packaged, or unpacked
Second stage of processing	Products from stage one can be further processed to products from stage two to extend their shelf-life Examples: plant oils, dairy products	Adding of several other substances can be necessary High technological level

2.2.2 Food processing and classification in law

The basic general requirements for processing, treatment and marketing of foodstuffs are set out in EU Regulation (EC) No 852/2004 on food hygiene:

> Article 2: Definitions
>
> 1. For the purpose of this regulation:
>
> (b) ‘primary products’ means products of primary production including products of the soil, of stock farming, of hunting and fishing;
>
> (m) ‘processing’ means any action that substantially alters the initial product, including heating, smoking, curing, maturing, drying, marinating, extraction, extrusion or a combination of those processes;
>
> (n) ‘unprocessed products’ means foodstuffs that have not undergone processing, and includes products that have been divided, parted, severed, sliced, boned, minced, skinned, ground, cut, cleaned, trimmed, husked, milled, chilled, frozen, deep-frozen or thawed;
>
> (o) ‘processed products’ means foodstuffs resulting from the processing of unprocessed products. These products may contain ingredients that are necessary for their manufacture or to give them specific characteristics.

Another definition of unprocessed food is given in EU Regulation (EC) No 1333/2008 food additives:

> Article 3 Definitions
>
> ‘unprocessed food’ shall mean a food which has not under-gone any treatment resulting in a substantial change in the original state of the food, for which purpose the following in particular are not regarded as resulting in substantial change: dividing, parting, severing, boning, mincing, skinning, paring, peeling, grinding, cutting, cleaning, trimming, deep-freezing, freezing, chilling, milling, husking, packing or unpacking

Therefore, according to EU law it is essential for processing that the raw product has undergone substantial change during processing.

The stage of processing is also relevant for direct sales in Germany. Unprocessed agricultural products from stage 1 can be sold directly without registering a business, while stage 2 products need a registered business for sale, as presented in Table 25. (Landwirtschaftskammer 2015)

Information about processing is, however, not primarily addressed by the requirements of food labelling in the European Union. How and with what information food must be labelled, is set out in Regulation (EU) No 1169/2011 of the European Parliament and of the Council of 25 October 2011 on the provision of food information to consumers, also known as the Food Information Regulation. Within the mandatory information indications of processing can be included in the name of the food (e.g. smoked fish). This is explored further in Chapter 5.

Table 25 Processing stages in direct marketing (own table, based on Landwirtschaftskammer Rheinland-Pfalz 2015, p. 3)

Primary production	First stage of processing (=side business of farming)	Second stage of processing (=own business)
Pigs, sheep, goats, wild animals, cattle	Slaughtering and splitting into halves or quarters	Further splitting, ready-to-cook pieces, production of sausages, ham, etc.
By-products	Skins, fur, wool	Knitwear, clothing
Turkeys, geese	Slaughtering and splitting into halves	Further splitting and processing
Other poultry	Selling of whole animals	Further splitting and processing
Fish	Fish filet (also smoked)	Further processing
Milk and dairy products	Milk, butter, quark, cheese, yoghurt, other products with at least 75% milk	Condensed milk, ice cream, milk powder
Eggs	Cooking, colouring	Pasta, advocaat
Cereals	Flour, groats, oats	Bread, bakery products, cakes, muesli
Fruits	Peeling, splitting, drying, pickling, juices, fruit wines	Liqueur, spirits, fruit preserves
Vegetables, potatoes	Peeling, splitting, pickling, conserving, juices	Ready meals
Grapes	Most (partly fermented fruit juice), wine, secco by winemakers, spirits based on wine (raw or fine spirits)	Brandy and spirit products

2.3 Many classification systems with many purposes

There are different classification systems for processed food all over the world, which vary widely in particular aspects. A special case are those classification systems used to describe differences between foods from the professional foodservice perspective i.e. in or going out from a professional kitchen in horeca. Nonetheless, the higher (or rather the highest) stages of processing according to these systems tend to have several points in common.

Some classification systems are based on product type and stage of processing. Here, wholefood nutrition by Kollath (2005, pp. 34-35) should be mentioned as well as its further development in the form of the Orientation Table of the Gießener Vollwerternährung by von Koerber et al. (2004, pp. 190-

191). This classification system pursues a comprehensive approach and contains clear recommendations for nutritionists and consumers. Highly processed products are mostly preserved, while extremely processed products are primarily composed of isolated ingredients and may be used as supplements. Accordingly, foods which are highly processed are e.g. canned, refined (oils and sugar) and ultra-high temperature (UHT) treated. Extremely processed foods include frozen complete dishes as well as sweetened and flavoured products by addition of additives. By contrast, individual frozen, cooked, and pasteurised ingredients are only considered as moderately processed foods. In summary, methods which lead to a nutritionally unfavourable food composition and an addition of (questionable) additives constitute higher processing stages.

Poti et al. (2015) tackle this issue with a classification system which lists highly processed foods twice: as ingredients and as stand-alone foods. According to this system, industrial formulations and mixtures primary constitute highly processed foods. Similarly to the system of von Koerber et al., the addition of refined grains or added fat/sugar as well as flavouring and canning belong to a higher processing stage. Poti et al. (2015) speak about methods altering the ingredients used to the extent that they are no longer recognisable as regards their original source.

Furthermore, some classification systems are based mainly on the stage of processing. The NOVA food classification system of Monteiro et al. (2010, 2012, 2016) is an important representative for this kind of classification system. In contrast to previous systems, especially to von Koerber and colleagues, this system does not focus on nutrients or individual foods, but product groups based on their processing. In consequence, methods such as the addition of additives or the UHT treatment are already included in the first group of un- or minimally processed foods. Products of the following groups include further processing methods based on the previous group(s). The last and fourth group is called ultra-processed foods and contains industrial formulations typically with five or more ingredients and hyper-palatable additives with strong flavour (imitating or disguising). The foods are ready to eat, drink or heat and – specific to this case – often characterised by aggressive marketing and health claiming (Monteiro et al. 2016, pp. 31-33). The approach of Niggemeier and Schmid (2016, p. 207) takes a similar direction, based on the NOVA system, and adapted to a classical German diet. In this case, the first grade of processing with so-called fresh foods includes also e.g. the UHT treatment as well as pasteurisation, fermentation, and hydrogenation (of fat and oils). Moreover, in the IFPRI classification system, developed by the International Food Policy and Research Institute (IFPRI), the definition of highly processed foods emphasises the industrial character of mixtures and meals (Aswaf 2011, p. 186) as is the case in the NOVA system as well. These systems have been typically used to analyse consumption and public health data together.

The European food classification system by the International Agency for Research on Cancer (IARC) in turn has similarities with that of von Koerber and colleagues. Processed foods (the highest grade of processing) are foods which have been treated e.g. by hydrogenation, heat, or deep frying. Nevertheless, here too, the focus lies on industrially prepared foods and the use of industrial ingredients (Moubarac et al. 2014, p. 262).

Yet further classification systems pay special attention to the grade of readiness depending on the technological treatment to which the product has been exposed (Paulus 1978; Pearson et al. 2001). The preparation which is necessary to eat this food is important here. According to Paulus (1978, p. 8), there is a classification into ready to process, kitchen process, cook, heat, and eat (increasing

processing stage). Pearson et al. (2001, p. 235) speak about no, some, and considerable preparation (decreasing processing stage), while they give the opportunity to classify into non-convenience and convenience in a two-dimensional matrix as well.

Looking at ready meals and convenience food in more detail, van der Horst and colleagues developed a widely used classification system for convenience food. In this system, ready meals are highly processed as well, while e.g. chilled or frozen pizza and sandwiches are only moderately processed (van der Horst et al. 2010, p. 240). On the other hand, ready meals are classified by their way of preparation, e.g. whether they are canned (ravioli, chili con carne etc.) or chilled / frozen (lasagne, nasi-goreng etc.). Costa and colleagues complement the preparation methods necessary before eating with a classification in accordance with the shelf-life of the product. This is a classification which takes account of the processing methods which aim to preserve foods.

Common to most of these systems is the assumption that mixing and combining several ingredients in an industrial way through to industrial formulations leads to a high degree (and grade) of processing (Poti et al. 2015; Monteiro et al. 2016; Aswaf 2011; Moubarac et al. 2014). This includes the addition of additives for a longer shelf-life or a needed flavour. Furthermore, methods which lead to a quick preparation of complete dishes are commonly steps to a higher processing stage. The most significant differences are expressed clearly in the contrast between the approach followed in the Gießener Vollwerternährung by von Koerber et al. (2004) and the NOVA food classification system (Monteiro et al. 2016). These, along with the original system devised by Kollath, undertake a value allocation of the categories, all of which inversely associate degree of processing with value. The array of classification systems show that many have been developed for specific applications which vary and therefore a ranking of these is irrelevant. This underlines the need to state the proposed purpose of any classification system clearly and concisely.

Finally, the range of organic products in the market today covers items in all categories of all systems discussed here. This may be taken as an indication that the unique criteria for organic processing may need an own category system to take this into account.

3. Legal requirements for organic food processing

In this chapter the authors look in technical detail at the regulations and guidelines for food processing of the EU legislation for the organic sector as compared to several different organic associations. The results are generated from the latest versions of the associations' standards which are freely available on the websites of the respective organizations as far as these were available in English or German language. Central comparison criteria are regulations on processing methods as well as additives, processing aids and other substances used during processing. Selected countries here mean the countries of the consortium (i.e., CH, DE, FR, IT, NL. PL).

3.1 Producing food organically within the EU legislation

3.1.1 EU organic regulation and revision

The European Union provides binding rules for its member states on the production of organic agricultural products including food for human consumption. These are enshrined in the EU Regulation 834/2007[1] on organic production and labelling of organic products, which defines the aims, objectives, and principles of organics, and furthermore in two implementing regulations 889/2008[2] and 1235/2008[3] which elaborate on organic production, labelling, control, and import rules. These regulations cover all products sold in the European Union as organic products. The rules apply throughout the food chain and are oriented towards reducing any external inputs. Therefore any inputs must be approved by the European Commission prior to use. Regarding processed food the main points are that it shall be produced mainly from organic agricultural materials; non-organic agricultural materials can be included if listed in the annexes to the regulations or provisionally authorised. A guiding principle is that the true nature of the food products may not mislead, hence certain substances such as flavour enhancers (additives) but also techniques that would lead to this are not to be employed.

The regulations are constantly updated and have undergone a complete revision. The new organic regulation 2018/848[4] will apply from the first day of 2022. According to the new regulation food containing or consisting of engineered nanomaterials is now excluded. Contrastingly, production falling under the foodservice sector (horeca) is still excluded and subject to national regulations. A further change concerns the use of natural flavouring substances and preparations which are then restricted to those of the named ingredients. The list of food additives and processing aids has been adjusted so that it now includes changes to the conditions under which certain substances can be used, new permitted substances, and new requirements for substances to be organic by the first of January 2022. In the following sections we refer to the pre-revised regulations.

[1] Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91

[2] Commission Regulation (EC) No 889/2008 of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control

[3] Commission Regulation (EC) No 1235/2008 of 8 December 2008 laying down detailed rules for implementation of Council Regulation (EC) No 834/2007 as regards the arrangements for imports of organic products from third countries

[4] Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007

3.1.2 Additives and processing aids

In general, the list of additives and processing aids allowed for organic processing is a lot shorter than for non-organic food. While there are about 300 substances that are permitted for food processing by the general German and European food law, the EU regulations for organic food limit that number to 53. The Soil Association provides a very similar list. The other organic associations further reduce the allowed additives and processing aids to about half of what is permitted by the EU. Table 28 compares additives and processing aids that are allowed during processing of organic food between the different guidelines. Only those substances that are assigned an E number are taken into account. Besides those, other substances which could also serve as ingredients, like water or plant oil for example, are occasionally counted as processing aids as well. For reasons of clarity the distinction if a substance is permitted for plant or animal products which is made in the EU regulation and or product group specification made by the organic associations is not considered in this table. Within the associations' standards this distinction indirectly evolves through the product specific permission of substances. The EU regulation, however, also differentiates between the use of substances in food of plant or animal origin but does not provide any further information about which criteria this distinction is based on.

3.1.3 Processing methods

In all the considered guidelines the possible processing methods are indirectly limited by the restrictions concerning additives and processing aids. In addition, there are a few general regulations from the EU as well as the organic associations regarding specific processing methods. Generally forbidden by the EU and thus automatically for all organic associations as well are the use of ionized radiation and genetically modified organisms (GMO) (Article 9, 10, Regulation (EC) No 834/2007). GMO in this context does not only refer to the modified organism itself but also to so-called GMO derivatives meaning any substances that were generated by the use of GMO in any way.

Besides those two restrictions the EU only states that processing methods for organic food should preferably be mechanical, biological, or physical in nature (Article 6, letter d, Regulation (EC) No 834/2007). Furthermore, substances or processing methods may not be misleading about the true nature of the product (Article 6, letter c, Regulation (EC) No 834/2007). However, the EU regulation does not further specify any methods or substances that might fall into this category.

In addition to the use of GMO and ionized irradiation the organic associations exclude a few other processing methods. These are listed in the Appendix.

3.2 General processing regulations of organic associations

3.2.1 The International Federation of Organic Agriculture Movements

The International Federation of Organic Agriculture Movements (IFOAM) is the only international umbrella organization for organic associations and other stakeholders within the organic sector. It was founded in 1972 and currently counts 210 members in 34 European countries and affiliates in 120 different countries around the world. The IFOAM standard aims at harmonizing different organic standards around the world and can also be used for certification (International Federation of Organic Agriculture Movement [IFOAM], n.d.a, n.d.b, n.d.c, 2019).

In terms of organic processing, the overall principle of the IFOAM standard is to keep the organic integrity of the product. Therefore, several practices as well as substances for processing are prohibited. Specifically named in this context are the use of GMO, GMO derivatives as well as irradiation. Nanomaterials may not intentionally be manufactured. Additives and processing aids may only be used if they appear in certain lists referenced by the standard and if production is impossible without the substance. Processing methods must be biological, physical, or mechanical in nature. Apart from that, contamination and co-mingling with non-organic products and other undesirable substances must be minimized and/or prevented through different measures. These mostly refer to strict separation during processing, storage and transport as well as thorough cleaning of machines and storage containers (IFOAM, 2014, last change 2017). Except for the regulation about nanomaterials none of these guidelines about processing show noteworthy differences from the EU regulation. Beyond that, the IFOAM does not provide any further specifications regarding processing methods and substances. Therefore, the IFOAM standard is not considered further in the following tables and study.

3.2.2 Organic associations in Germany

In Germany there are nine private organic associations that provide their own standards for organic production which deviate in some respects from the EU regulation. These are Biokreis e.V., Bioland e.V., Biopark e.V., Demeter e.V., Ecoland e.V., Ecovin e.V., Gaä e.V., Naturland e.V. and the Verbund Ökohöfe e.V. Ecovin only provides guidelines for the production of wine and similar drinks and the Verbund Ökohöfe's standards are currently not available online which is why only the remaining seven associations will be considered in the Tables in Appendix A. All the associations subdivide their guidelines into different product groups to provide more specific processing regulations. Besides Demeter they are all German associations only. Demeter e.V. also has an international association and other offshoots in different countries. In this paper the regulations of Demeter international are taken into consideration. However, there are barely any differences between the international and the German standard. Those that exist in terms of additives and processing aids are marked in the Appendix tables; otherwise the two standards are almost identically worded. Besides their general regulations on organic processing the German organic associations subdivide their guidelines into different product groups to give more specific instructions on permitted and prohibited processing methods and possible substances used during processing of the respective products. The tables in Appendix A compare the regulations regarding additives, processing aids, microorganisms, enzymes, and flavourings as well as processing methods and labelling requirements for the different product groups covered in the German associations' guidelines.

3.2.3 Bio Suisse in Switzerland

Bio Suisse is the umbrella organization of the organic sector in Switzerland. It was founded in 1981 and currently includes more than 90% of Swiss organic farmers and gardeners organized in 32 member associations (e.g. demeter, biofarm, FiBL). In comparison to Germany only 63,3% of organic farmers are a member in one of the organic associations (vgl. Bund Ökologische Lebensmittelwirtschaft [BÖLW], 2019, p. 7). Products that are produced in compliance with the Bio Suisse Standards are labelled with the so-called "Bud" (Bio Suisse, n.d.a, n.d.b).

The Bio Suisse Standard contains a general part about processing and specific regulations for different product groups (e.g. milk, meat, vegetables). Within the product groups regulations are further

specified for individual products (e.g. drinking milk, yoghurt). Permitted and prohibited processing methods are clearly listed. In addition, a second list determines those methods which must be labelled on the product if used during processing. It is necessary to distinguish if only one ingredient was processed in this way or the whole product (e.g. pasteurized milk in a fruit yoghurt) (vgl. Bio Suisse, 2019, p. 170). Tables in Appendix A show these specific regulations. The general regulations also attach importance to sustainability by referring to the Brundtland-Report definition (vgl. Bio Suisse, 2019, p. 44). Furthermore they provide different labels for products with "regional" (i.e. from Switzerland) raw materials and products with more than 10% imported ingredients (vgl. Bio Suisse, 2019, p. 165).

BioSuisse standards' subdivision is much more detailed than those found in the German associations' standards. The processing regulations for different product groups are further specified for specific products. Tables referring to BioSuisse show these specific regulations. Information marked in blue is not directly stated in the standard itself but was gathered through email contact and a telephone call with BioSuisse[5].

Table 26 BioSuisse processing regulations for milk in general

Permitted	Prohibited

- Careful processing (not further specified)
- Pasteurization (>72°C, 15 sec. or temperature-time-relation with same effect)[6]
  o positive peroxidase detection afterwards, negative phosphatase detection[1]
  o Once before storing for UHT-products, milk powder and butter
- Thermal treatment (positive phosphatase detection afterwards)
- (double) bactofugation
- UHT treatment (afterwards: ß-lactoglobulin >500 mg/l, except coffee cream) (135°C-155°C[1] for a few seconds – because of the very short period it is considered more careful processing than high-temperature pasteurization)
- Homogenization
  o with pasteurization: 100 bar, max 120 bar (exceptions for specific products)
  o with UHT: 180 bar, max 200 bar, gradual homogenization is permitted
- Standardization (with reservations)
- Microfiltration (with reservations: see specific product regulations)
- Ultrafiltration
- Reverse osmosis
	- High-temperature pasteurization (85°C-135°C, negative peroxidase detection afterwards[1], lower temperature but longer time than UHT – considered less careful)
	- Sterilization
	- Double and multiple pasteurization for pasteurized milk, cheese, curd and cream

Source: own table based on (vgl. Bio Suisse, 2019, pp. 183–191)

3.2.4 The Soil Association in the United Kingdom

The Soil Association is UK's largest membership charity organisation for organic food and farming. It was founded in 1946 and the first standards were established in 1967. These standards are based

[5] Hartong, S. (2019, 09.07.). Personal communication. Fragen zu den Richtlinien für die Erzeugung, Verarbeitung und den Handel von Knopse-Produkten. (email)

Hartong, S. (2019, 09.07.). Personal communication. Fragen zu den Richtlinien für die Erzeugung, Verarbeitung und den Handel von Knopse-Produkten. (telephone call)

[6] Regulated by the general Swiss food regulations (Verordnung des EDI über die Hygiene beim Umgang mit Lebensmitteln, 2018), Art. 26 b. and Art. 49

on four Organic Principles – The Principles of Health, Ecology, Fairness and Care. By today, 70% of organic food in the UK is certified by Soil Association Certification (Soil Association, n.d.a, n.d.b, n.d.c). Compared to the other standards considered in this paper, the Soil Association processing standard does not exceed the EU regulations to such a high extent in terms of strict prohibitions. Instead, in most cases the respective EU guideline is cited and extended with the so called “Soil Association Guidance”. This includes examples and specific advice on how to ensure compliance with the regulations. In the cases that there is a “Soil Association higher standard” which exceeds the actual EU regulation, there are always reasons provided for the implementation of the respective additional requirements. Thus, the Soil Association standard mostly forms a guideline on how to implement the EU regulation and as such is very relevant to the project aims of ProOrg. The Soil Association does not subdivide its standard into product groups.

4. Market overview of processed foods

4.1 Food basket share captured by organic processed food

Nutrition surveys typically seek to assess and analyse the nutritional situation of populations or population groups. In consequence they are designed to collect relatively detailed data about the consumption of foods and food groups. However, since the underlying analysis often primarily focuses on nutrients to assess nutrient status, information about other quality aspects of food is not regularly collected. To research what share of food baskets are not just organic, but also processed organic products, appropriate data on the consumption of such organic products is needed. In this chapter countries in Europe were selected for study to coincide with the ProOrg project consortium. In Germany, there are data on organic consumption from the youngest national consumption survey Nationale Verzehrstudie II (NVS II), but the consumption is clustered along food groups and not along the stages of processing.

Within the survey NVS II the food consumption of the German population has been examined. Food consumption data of 15.371 participants were collected from 2005 to 2006 and analysed in regard of the nutritional value of the food. Information on the nutritional value has been calculated according to data in the federal nutrient database, Bundeslebensmittelschlüssel. The NVS II differentiates foods in the categories as shown in Table 27. (MRI 2008, pp. 29f)

Therefore, to answer the question with data from the NVS II, the original data needs to be clustered completely newly with a food classification system based on the stage of processing and not based on food groups. This work has partly been done by Niggemeier and Schmid (2016) with the NOVA food classification, adapted to a typical German diet. They analysed data from NVS II as well as the EsKiMo study (children aged 6-12 years) and the VELS study (children from age 1 until age younger than 5 years) for the proportions of fresh food, processed and highly processed food products. Their analyses show that children obtained 40% of their energy from fresh and highly processed food products and 60% from processed foods. Adults obtained 50% of their energy from fresh foods, 25% from processed foods and 25% from highly processed foods. Children with a high consumption of highly processed food products ate more meat products, sausages, candies, and soft drinks than children with a high consumption of fresh food. These children had higher consumption rates of vegetables, fruits, milk, fruit juices and fruit nectar. With adults, a higher percentage of processed and highly processed products in the diet was linked to an increased consumption of meat products and sausages. Like the children, adults with the highest amount of highly processed products in diet also consumed more candy, soft drinks, and beer. This suggests that a high consumption of highly processed products is associated with a high consumption of meat products and sausages, sweets, soft drinks, and beer for adults.

To access more market data for the aforelying study, several food retailers were contacted, including *tegut*, *Weiling*, *Superbiomarkt*, *dennree*, *Alnatura*, *Rewe*, *Edeka* and one of the biggest German dairies (Deutsches Milchkontor), but none were able to provide or share data. Additionally, consumer research companies were contacted (GfK, Nielsen, AMI, BVLH, Eurostat, Handelsdaten, Kommunikationsberatung Klaus Braun, WOBkom Horst Hartmann, Euromonitor, IFH Köln ICC Köln) as well as other institutes (University of Bonn, former Institute for Organic Agriculture; Organic Data Network;

Department of Agricultural and Food Marketing of the University of Kassel). No usable data was discovered because the data are not classified according to any stages or categories of processing.

Table 27 Food groups of the German national consumption survey NVS II

Category	Explanation
Bread and cereals, bakery products	Bread and rolls, sweet bakery products like cake, salted bakery products like pizza, cereals, rice, pasta
Vegetables, mushrooms, and legumes	Includes fresh vegetables and meals like salad; both raw and cooked
Potatoes	Potatoes, French fries, potato pancakes, mashed potatoes, excluded: crisps
Fruits, fruit products	Fresh and dried fruits; excluded: fruit juice
Nuts and seeds	Excluded: roasted and salted nuts and seeds
Fats	Mostly spreadable fats like butter or margarine; fat and oil used for cooking are put into the category of the meals
Milk, dairy products, and cheese	Milk from cows, goats, and sheep; rice pudding, cereals with milk or yoghurt, cheese meals like cheese salad; pudding
Eggs	Mostly eggs from chicken; boiled eggs, scrambled eggs, fried egg; meals based on eggs like egg salad, omelette, egg pancake if egg is the main ingredients; excluded: eggs used for the production of meals or bakery products
Meat and sausages	Meat from all animals, offal; meals based on meat like hamburger or sausage salad
Fish	Fish, shellfish; meals based on fish or shellfish
Soups and stews	
Sauces and seasoning products	Mustard, vinegar, soy sauce, dried herbs
Sweets	Candy, Ice cream, sweet spreads, sweeteners
Snacks	Snacks based on potatoes, salted bakery products, salted and roasted nuts and seeds, flips, popcorn
Beverages	Non-alcoholic: water, coffee, tea, fruit and vegetable juice, lemonades, alcohol-free beer
	Alcoholic: beer, wine, sparkling wine, spirits and other (alcopops, cocktails)
Other	Soy products, vegetarian spreads, some desserts; energy or protein preparations; formula diet products

For the German food market, we were able to access sales data from one consumer research business. The data are from EAN-coded products sold in specialized organic shops.

4.1.1 Organic food market in Western Europe

General information on the organic food market is given by a report of the Rabobank. The report includes market data from Western Europe (Finland, Sweden, Norway, Great Britain and Ireland, Denmark, Germany, The Netherlands, Belgium, France, Spain, Italy, and Austria). Fresh food in general outgrows processed food over the past years in general. This is the same with organic food. The market growth of fresh organic food is much higher than that of organic processed food. The share of organic processed food in retail is only 2.2% compared with all types of processed food. The product category with the highest penetration rate is baby food, followed by milk and infant formula. This is followed by spreads, tea and pasta, breakfast cereals, edible oils, soup, coffee, and bread. The

lowest penetration rates are for the categories frozen foods, sweet biscuits, savoury snacks, confectionary, sauces, ready meals, and ice cream. Products with higher penetration rates are relatively simple products with a limited number of ingredients. Organic processed foods are often premium priced, so the value penetration of organic processed food is higher than the volume penetration. Rabobank expects an ongoing growth of the organic processed food market in Western Europe. (van den Berg 2018)

4.1.2 Germany

The Bund Ökologischer Lebensmittelwirtschaft e.V. (BÖLW) publishes sales data about the German organic market every year. The reports can be downloaded for free from their homepage. The data used for the reports are from the Agricultural Market Information Company (AMI) and the Federal Office for Agriculture and Food (BLE). Table 28 shows the sales volume of different organic products over the years from 2011 to 2017. The largest volume goes to milk in every year, followed by eggs and vegetables. The sales volume of wine and beef has increased, while that of fruit has slightly decreased over this period.

Table 28 Sales volume in million EUR of different organic products (own table, based on the reports from BÖLW 2011-2017)

	2011	2012	2013	2014	2015	2016	2017
Milk	283	284	311	346	352	387	467,6
Eggs	141	169	185	227	240	276	286
Vegetables	187	223	215	208	253	300	267,8
Cereals	203	217	214	227	228	235	259
Beef	133	147	150	142	162	182	212,2
Wine	72	83	87	108	150	150	185
Fruits	102	115	103	106	84	96	97,1
Pork	69	76	68	66	65	81	95,9
Sugar Beet	19	19	17	17	26	27	71,1
Potatoes	38	55	76	34	61	84	60,9
Poultry	29	27	31	36	38	39	49,3
Sheep	18	19	19	18	21	22	23,1
Pulses	31	33	27	30	33	16	22,5
Oil seeds	4	8	8	10	12	18	20,7
Nursery Garden	21	25	22	20	15	15	18
Ornamental plants	6	3	7	7	7	7	9

Colours signify low values (red), medium values (yellow), and high values (green)

The big increase for sugar beet in 2017 is attributed to the growth of farmland that has been changed from non-organic to organic farming (BÖLW 2019, p. 3).

Milk

In 2017, 3,0% of milk that was delivered to milk processing businesses was organic (2016: 2,5%) (BLE 2018 p. 13). The production of drinking milk decreased by 4,7% compared to 2016 due to the

reduced consumption. The most prominent drinking milk products were full fat milk and fat reduced milk. (BLE 2018 p. 15) The per capita consumption was 51,5 kg in 2017 (BLE 2018 p. 16).

AMI kindly provided the authors with two slides that show the demand for UHT-milk, traditionally pasteurized milk, and milk with an extended shelf life for the years from 2014 to 2018. One slide contains data about organic and non-organic milk, one slide contains only data about organic milk. AMI uses market data from the consumer research company GfK. These data have been compiled into Table 29 and Figure 1 below.

Table 29 Consumption of milk (own table, based on AMI data)

Type of milk	Consumption in million liters per year				
	2014	2015	2016	2017	2018
Ultra-high temperature treated milk (UHT)	2546	2554	2552	2467	2390
Only organic	39	45	48	62	76
Milk with extended shelf life (ESL)	1152	1223	1241	1225	1118
Only organic	128	142	150	168	173
Traditionally pasteurized milk	162	132	141	152	232
Only Organic	59	64	75	76	78

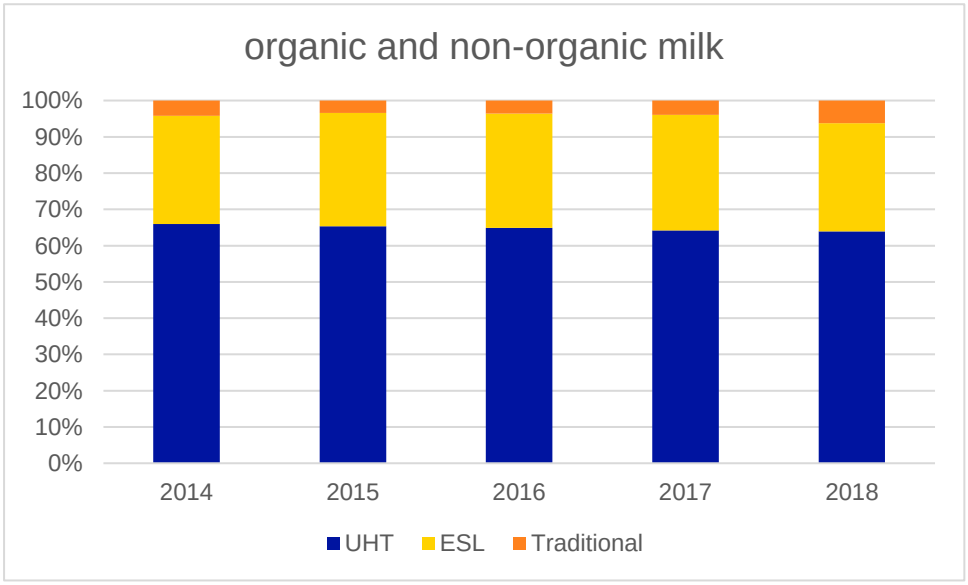

Figure 1 Consumption of organic and non-organic milk (own figure, based on AMI data)

For both non-organic and organic milk, the consumption of UHT milk decreased slightly over the last four years. The consumption of ESL-milk increased from 2014 to 2016 and then decreased to under the level of 2014 in 2018. Meanwhile the consumption of traditionally pasteurized milk first decreased from 2014 to 2015, but then increased again until 2018, when the consumption was higher compared to that in 2014. The consumption of organic milk increased from 2014 to 2018 in all milk types.

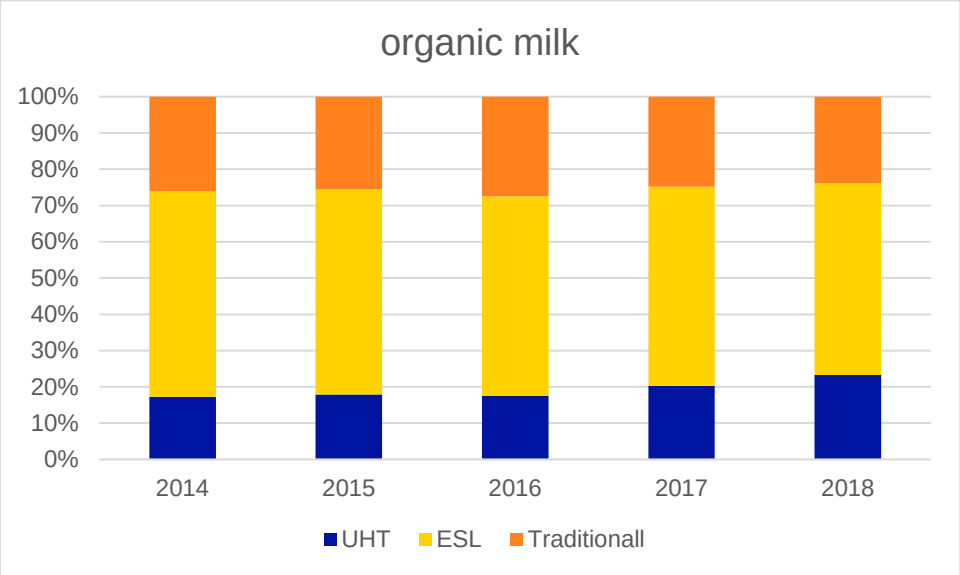

Figure 2 Consumption of organic milk (own figure, based on AMI data)

Fruit Juice

The Verband der Deutschen Fruchtsaftindustrie e.V. (VdF) kindly provided the authors with presentations containing market data on the German fruit juice market. The data are from GfK household panels with 30.000 households and go back until 2014, partly until 2009. The data differentiates between fruit juice made from concentrate and direct juice. As shown in Figure 3 the sold mass of direct juice increased from 2009 to 2017. Unfortunately, the data from VdF does not include total sales data from all types of fruit juices, but it includes the relation between the sales from direct juice compared to juice made from concentrate (Figure 4).

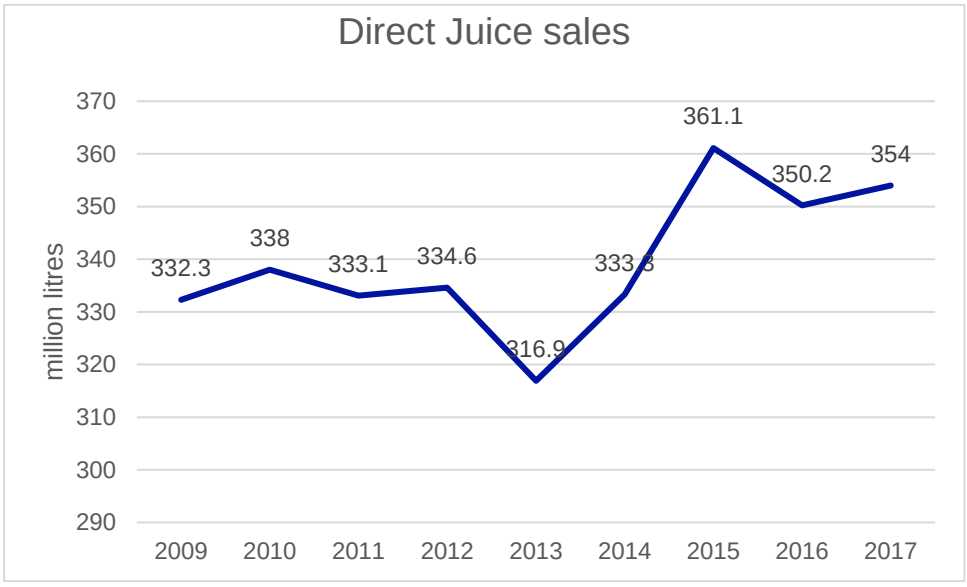

Figure 3 Direct Juice sales 2009-2017 (own figure, based on Vdf)

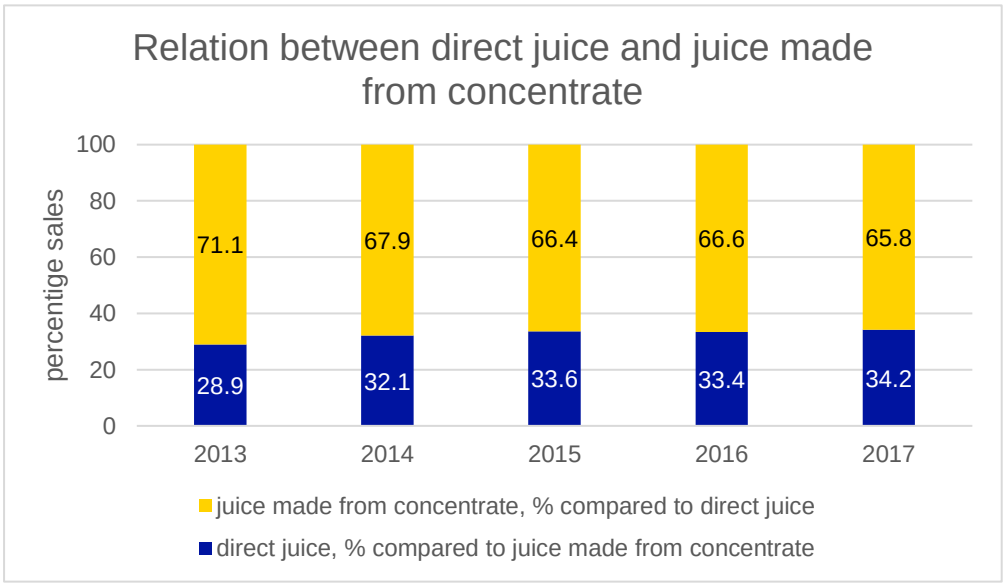

Figure 4 Relation between direct juice and juice made from concentrate (own figure, based on VdF)

The sale of fruit juice made from concentrate is higher than from direct juice, but it decreased over the last four years constantly, while the sales of direct juice increased.

The VdF presentations also offers sales data from only organic products in relation to the sales data from the total fruit juice market (Figure 5).

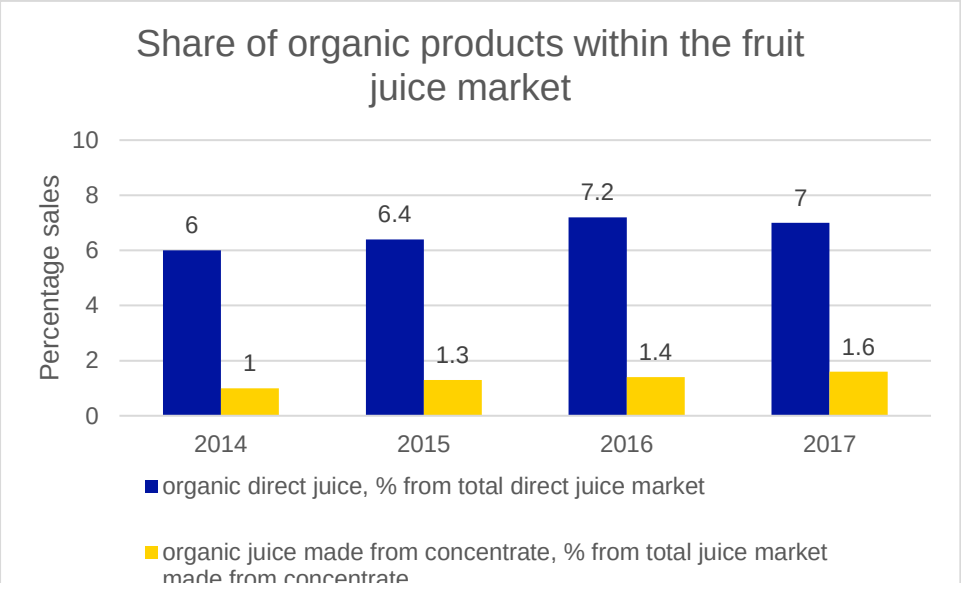

Figure 5 Share or organic products within the fruit juice market (own table, based on VdF)

The total share of organic products increased since 2014 consistently, with a higher percentage of direct juice compared with juice made from concentrate. Sales of both types of juice are increasing over the years.

The VdF presentations also include more market data as shown in Table 30. The different categories are:

- Customer reach: Percentage-shares of all households that at least once purchased the product in the relevant period
- Intensity: Average purchased quantity per buyer (= Quantity / purchase * frequency)
- Volume per purchase: average purchased amount of a buyer's household per shopping unit
- Frequency: average number of shopping records per buyer household in the considered period

The VdF presentations gave no information about the rate of repetitions of organic food purchases. In other literature it is defined as the proportion of customers that bought the product more than just once (Wübbenhorst 2018).

The customer reach of juice made from concentrate slightly decreased while the customer reach of direct juice slightly increased with a peak in 2015. The customer reach of ambient direct juice remained stable, while the customer reach of chilled direct juice increased.

Table 30 Key facts fruit juice market (own table, based on VdF)

	2013	2014	2015	2016	2017
Juice made from concentrate					
customer reach [%]	72,2	70,6	71,1	69,5	68,4
rate of re-buy		78,9	79,2	78,3	78,1
intensity	27,2	25,5	25,5	25,3	24,7
volume per purchase	3,6	3,4	3,3	3,3	3,2
frequency	7,5	7,5	7,7	7,6	7,6
Direct juice (total)					
customer reach [%]		52,8	54,9	53,7	53,6
rate of re-buy		70,4	71,9	71,5	71,8
intensity		16,1	16,7	16,5	16,4
volume per purchase		2,4	2,4	2,4	2,3
frequency		6,6	6,9	6,9	7
Direct juice (chilled)					
customer reach [%]	14,5	16,1	17,4	17	17,7
rate of re-buy		55,8	57,3	57,2	59,3
intensity	7,6	8,2	8,7	8,8	8,4
volume per purchase	1,6	1,6	1,6	1,5	1,5
frequency	4,7	5,1	5,6	5,7	5,6
Direct juice (ambient)					
customer reach [%]	48	47,2	48,7	47,5	47,7
rate of re-buy		67,5	68,4	68,4	68,6
intensity	14,3	15,3	15,7	15,5	15,3
volume per purchase	2,8	2,6	2,7	2,6	2,6
frequency	5,2	5,8	5,9	5,9	5,9

4.1.3 France

Data from the French organic food market focused mostly on agriculture. The processing of the raw material was not included in the reports sighted. The consumption of organic food increased between 2013 and 2017 from 4.383 EUR to 7.921 EUR (Fléchet 2019). The share of the different food groups remained nearly the same (Table 31).

The report "Le marche en bio 2018" states an increase of 34% for processed products and an increase of 16% for fresh fruits and vegetables. (Agence Bio 2018 p. 27)

Table 31 Share percentage of the different food groups of the organic food market in France (own table, based on Fléchet 2019)

	2013	2014	2015	2016	2017
Meat	11	11	11	10	10
Dairy products	17	16	18	17	16
Seafood, frozen food, ready meals	7	7	6	7	7
Fruits and vegetables	19	19	18	19	19
Grocery	23	24	23	23	24
Bakery	7	7	7	7	7
Non- alcoholic beverages	5	5	5	5	5
Alcoholic beverages	12	13	13	12	13

The market share of direct juice increased from 47,1% in 2010 to 61% in 2016. The market share of fruit juice made from concentrate was 22% in 2016, while nectar had 16% and smoothies 1,5% in 2016. (Unijus 2016) New trends in the French fruit juice market are cold pressed juices and high pressure processed fruit juices (Agro-media 2018).

4.1.4 Italy

The share of organic products of the whole food basket increased from 0,7% in 2000 to 3,3% in 2018 (Zucconi 2019). The sales volume of fresh milk (all types of fresh milk, including ESL milk) has increased by 9,5% between 2017 and 2018, while the sales volume of UHT milk increased by 32,8% during the same time (Zucconi 2019).

The Nielsen Company collected some data on the organic food market in Italy that represent a whole organic shopping basket with different food categories. They are not ordered by stage of processing, but in some cases, it is possible to compare two similar products, that have undergone different processing methods.

Fresh milk includes all types of fresh milk, traditionally pasteurized milk as well as ESL milk. **UHT milk** is milk that has undergone an ultra-high-temperature treatment and has a longer shelf life than all types of fresh milk.

Cream (panna) and **pesto** are also available in fresh and UHT quality.

Bread is differentiated in **fresh bread** (pane fresco) and **industrial bread** (pane industrial). Fresh bread is bread normally consumed within 24 hours of its manufacture. It is not necessarily completely artisanal, but often is. Industrial bread is packaged sliced bread (sandwich loaf) that is sold not only in discounters.

With juice, one can differentiate between **juice 100%** (succhi 100%), which is direct juice or juice made from concentrate, and **pure fresh juice** (succo puro fresco), that is fresh squeezed fruit juice, to be kept refrigerated and to be consumed within a few days.

The available data cover the years from 2016 to 2018. They include the following information:

- The share of the organic food product compared with all other variants of this product (How much of this product is sold in organic quality?).
- The share of the single product compared with the whole organic shopping basket (What is the percentage of this product in the whole organic shopping basket?).
- The difference in trend of sales between the same organic and non-organic category

Table 32 shows that the share of the organic variant increased for fresh milk and UHT, cream UHT, bread and juices 100%. The share remained nearly stable for bread and industrial bread, while it decreased for fresh pesto and pure fresh juice.

Table 32 Share of the organic products in total of all other variants of this product (own table, based on Nielsen Trade*Mis)

Products	2016	2017	2018
Fresh milk	6,29	7,07	7,71
UHT milk	0,65	1,1	1,4
Fresh cream	0,35	0,38	0,37
UHT cream	0,84	0,85	1,11
Fresh Pesto	3,15	2,97	2,88
Pesto UHT	2,42	3,91	4,74
Fresh bread	0,45	0,9	1,4
Industrial bread	3,36	3,36	3,37
Juice 100%	6,77	8,11	9,53
Pure fresh juice	23,91	19,39	17,86

Table 33 Share of the single product compared with the whole organic shopping basket (own table, based on Nielsen Trade*Mis)

Products	2016	2017	2018
Fresh milk	2,98	2,85	2,87
UHT milk	0,46	0,67	0,80
Fresh cream	0,02	0,01	0,01
UHT cream	0,08	0,07	0,08
Fresh Pesto	0,21	0,18	0,17
Pesto UHT	0,09	0,14	0,17
Fresh bread	0,02	0,03	0,04
Industrial bread	0,79	0,70	0,68
Juice 100%	0,51	0,57	0,66
Pure fresh juice	0,62	0,56	0,51

Table 33 indicates that the largest share of all organic products in the years considered has been fresh milk. The share of UHT milk increases from 2016 to 2018. Within the group of breads, industrial bread has a bigger share than fresh bread, but the fresh bread share is increasing slightly over the years, while industrial bread's share is decreasing. With cream, the UHT variant has a larger share than the fresh one. For pesto, the fresh variant had a larger share in 2016 than the UHT variant, but this changed and in 2018, the shares of both were the same.

Table 34 Year-on-year trends of organic shares (own data, based on Nielsen Trade*Mis)

Products	2016	2017	2018
Fresh milk	12,5	12,4	8,9
UHT milk	7,8	70,5	27,3
Fresh cream	24,6	9,1	-2,9
UHT cream	43,2	0,7	30,4
Fresh Pesto	4,3	-6,4	-3,5
Pesto UHT	34,8	65,7	22,6
Fresh bread	-23,5	88	57
Industrial bread	5,1	0,1	0,5
Juice 100%	22,2	21	26,2
Pure fresh juice	42,3	-19,3	-8,2

Table 35 Year-on-year trends of single products in organic basket (own table, based on Nielsen Trade*Mis)

Products	2016	2017	2018
Fresh milk	7,6	11,9	7,3
UHT milk	1,5	71,9	26,3
Fresh cream	23,6	15,2	-0,1
UHT cream	7,5	2,1	30,2
Fresh Pesto	8,5	1,2	2,5
Pesto UHT	39,6	72,7	30,3
Fresh bread	-24,9	77,6	48,1
Industrial bread	4,6	4,1	2,6
Juice 100%	24,5	32,4	29,4
Pure fresh juice	57,3	5,7	-3,7

4.1.5 Poland

The organic food market in Poland is in a dynamic developing state with a high increase of organic farms since 1990. Organic farmland in Poland is dominated by fodder growth, followed by pastures and meadows as well as cereal farming. (Jezierska-Thöle, Gwiaździńska-Goraj and Wiśniewski 2017) In contrast, the per capita consumption of organic food is low in Poland, compared with other European countries. For example, Swiss consumers spent 274 EUR per capita on organic food in 2016, while Polish consumers only spent 5 EUR. (Średnicka-Tober n.d.) Within field research in different supermarkets in Warsaw and in online shops, Misztal et al. (2018) found out that the most dominant food groups in Polish shops are sweets and snacks, teas, soft drinks, juices, and products from the group such as groats, rice, sesame seeds and grain. There was a lack of meat, dairy products, mushrooms, wine, ice cream and desserts, as well as fresh fruits and vegetables. Data with which conclusions on different stages of processing would be able were not available.

4.1.6 Switzerland

The umbrella organization for the organic sector in Switzerland is Bio Suisse. The organization was founded in 1981 and manages the guidelines of their own organic label. Every year, Bio Suisse publishes a report on the organic food market in Switzerland. They use their own data and data from GfK data and analytics company. The reports can be downloaded for free from the Bio Suisse website. Table 36 shows how many consumers bought products from different categories in organic quality at least once a year. The products most frequently bought in organic quality are fruits and vegetables, but the consumption frequency decreased since 2016. Animal products are also consumed in a relatively high frequency, especially eggs, milk, and dairy products, but not fish.

Table 36 Share (percentage) of how many of the consumers bought the product in organic quality (own table, based on Bio Suisse reports 2016-2018)

	2016	2017	2018
vegetable	70	68	60
fruits	65	64	59
cheese	39	48	42
eggs	51	48	41
drinking milk	35	33	31
dairy products	45	40	30
fresh meat	36	39	30
fresh bread	32	26	27
pasta	16	15	16
processed staple food	27	23	15
sausages	13	17	14
fish	17	14	13
deep- frozen products	8	9	10
vine	14	13	8
other bakery products	8	6	8
convenience products	4	5	5

Colours signify low values (red), medium values (yellow), and high values (green)

The least consumed products through all the years are convenience products and the so-called "other bakery products" that exclude fresh bread and deep-frozen products. Table 37 shows the share of organic products in the whole shopping basket and across the different product types. These data exclude all sales from specialized organic shops, direct sales, and discounters. Therefore, they do not include all sale channels for organic products. The categories are not completely consistent. In the years 2015-2017 vegetables, salads and potatoes are counted once in a summed-up category and also in single categories. Cheese was in an own category until 2018, then it was included in the category "dairy products". Including cheese into the category "dairy products" seems to have no influence on the share of dairy products. Unfortunately, Bio Suisse has no glossary or other explanation of the categories, so the data of the inconsistent categories must be analysed and interpreted with great care. On query, Bio Suisse stated that the product categories are identical for five years. The share of the whole shopping basket increased constantly from 2012 until 2018, fresh products as well as packaged products. Eggs are the products that have been bought most in organic quality throughout all the studied years, followed by fresh bread. The least consumed products are sweets and snacks, preceded by beverages. However, even their share of the food basket increased since 2012. Fresh and durable convenience product shares were raised.

Table 37 Share (percentage) of organic products in the whole food basket and different product categories (own table, based on Bio Suisse reports 2012-2018)

	2012	2013	2014	2015	2016	2017	2018
Whole shopping basket	6,3	6,9	7,1	7,7	8,4	9,0	9,9
fresh products	8,5	9,1	9,3	10	10,8	11,5	12,8
packaged products	4,1	4,6	4,9	5,3	6,0	6,4	7,1
eggs in total	20,5	21,2	22,7	24,3	25,5	26,6	27,6
vegetables				18,6	21,2	23,1	
fresh bread	18,8	20,3	19,8	20,1	20,7	22,1	25,3
vegetables, salads, potatoes	12,9	13,5	14,6	16,1	18,1	19,6	21,8
salads				15,6	17,5	18,7	
fruits	8,6	9,2	10,1	11,1	12,9	13,9	16,2
dairy products	10,1	10,8	11,0	11,8	12,6	12,9	11,0
potatoes				12,1	12,1	13,2	
breakfast, side dishes, pet food	6,9	7,5	8,5	9,8	11,2	12,3	13,6
fresh convenience products	8,5	9,6	10,3	10,5	10,2	10,7	11,6
durable convenience	3,6	4,1	4,4	5,3	6,6	7,5	8,4
cheese total	5,6	6,3	6,0	6,2	6,5	6,7	
fish and meat (without frozen products)	4,4	4,8	4,8	5	5,3	5,6	6,1
bread and bakery products	4,8	4,9	4,6	4,5	4,8	4,9	5,4
deep frozen products	3,8	4,1	3,9	4,1	4,3	4,3	4,7
beverages	2,3	2,6	2,7	2,9	3,2	3,3	3,7
sweets, snacks	1,5	1,7	1,8	2,0	2,7	2,9	3,2

Colours signify low values (red), medium values (yellow), and high values (green)

4.1.7 Summary

In Europe, organic foods are sold more in fresh quality than packaged. The biggest amount of sold organic packaged food is baby food. In France, market growth for processed food, but also for fresh food is evident. Important organic product groups in Germany and Switzerland are milk, eggs, fresh fruit and vegetables, while these are lacking in Polish supermarkets. In Germany and Italy, organic milk is mostly sold in fresh quality, but the amount of UHT milk sold is increasing. The organic fruit juice market in Germany is dominated by pure fresh juice, but with an increasing share of juice made from concentrate. For fruit juice in general, there is more juice made from concentrate in the market, but with a decreasing tendency.

4.2 Organic processed food as a share of the range of organic retail goods

The global organic food market has seen a year-on-year consistent growth since the early 2010s and is forecast to grow in double digits rates to 2024 (Research and Markets, 2019). While general retail data for organic product sales are available, these generally do not distinguish across processing categories; the challenge being that there is no standardization of what is meant with processing in market research or other surveys. The data used within this report can only be a first attempt at answering the question. With selected European countries the authors mean the countries of the

ProOrg consortium. As mentioned, it is indicated that in the product groups milk and fruit juice in Germany the largest sales amounts have been and still occur in the less processed types, but the amount of more highly processed variants is increasing over the last years. In France the number of sales of ready meals has been stable, while in Switzerland the turnover of products classified as convenience steadily increased.

The Food Systems Dashboard (https://www.foodsystemsdashboard.org/) by John Hopkins University provides information about food systems worldwide in a world map view. It provides information about the retail value of ultra-processed foods (UPP), in general and per capita. For the description of ultra-processed food, the NOVA classification is used (Monteiro 2018); data are provided by Euromonitor International. The information provided does not distinguish between organic and non-organic products and deeper details of the Euromonitor data bases were not accessible. The worldwide per capita consumption of UPP rose from 203 USD in 2017 to 207 USD in 2018. Comparing the growth in retail value of ultra-processed food sales from 2012 to 2017 worldwide, the highest growth took place in Syria (+83%), Qatar (+82%) and Bangladesh (+80%). There are some countries with no growth (e.g. Luxembourg) and countries with a reduction of sales, like Latvia (-4%).

The growth in retail value of ultra-processed food sales of the countries of the consortium in the years 2012-2017 are shown in Table 38. In most of the countries, there was a negative growth in retail, especially in Italy and The Netherlands. Only in two countries the retail of ultra-processed food sales increased in Denmark, there is a small growth of 1%, and in Hungary the growth was 5%.

Detailed data about the retail sales value of ultra-processed food come along in comparison with data of packaged food; these are defined as any food that is sold in a protective barrier such as plastic, canned, or paper. Table 39 gives an overview of the retail value of the countries of the consortium for the years 2017 and 2018 (Monteiro et al. 2018).

Table 38 Growth in retail of ultra-processed food sales in % in the countries of the ProOrg consortium, 2012-2017 (Source: own table, data by Euromonitor International, https://www.foodsystems-dashboard.org/compareandanalyze [29.06.2020])

Country	Growth in retail of ultra-processed food sales in percent, 2012-2017
Italy	-13%
The Netherlands	-11%
France	-7%
Poland	-6%
Germany	-4%
Switzerland	-2%
Denmark	+1%
Hungary	+5%

Table 39 Retail sales value of packaged and ultra-processed food sales per capita in the countries of the consortium, 2017-2018 (Source: own table, data by Euromonitor International, https://www.foodsystemsdashboard.org/countrydashboard [29.06.2020])

Country	Retail value of packaged food sales per capita in USD		Retail value of ultra-processed food sales per capita in USD	
	2018	*2017*	*2018*	*2017*
Italy	1289	1213	546	513
Denmark	1775	1667	1129	1058
The Netherlands	1216	1145	756	711
Germany	1198	1138	724	681
Poland	582	533	359	329
Switzerland	1983	1970	1062	1054
France	1376	1300	680	642
Hungary	691	652	380	348

The retail value of packaged and ultra-processed food sales increased in all countries of the ProOrg consortium between 2017 and 2018, even in the countries that had a negative growth in retail of ultra-processed food sales from 2012 to 2017.

4.2.1 Analysis of sales figures of an organic supermarket according to NOVA

The aim of a thesis in 2019[7] was to examine whether and how the sales figures for high and low processed foods have changed in recent years in Germany. The sales figures of packaged food from 460 organic and natural food stores in 2016, 2017 and 2018 were provided by a data analyst. These sales figures were arranged according to product categories as they are used in food retail to classify products. The product groups were divided according to their degree of processing. Sales figures of product groups according to the degree of processing were examined. The Niggemeier (2017) classification system for processed foods was used for this purpose. Their system is based on the NOVA classification system but is adapted to the predominant form of diet in Germany and, in addition to the four main categories, has a large number of sub-categories.

The assignment of the products to the processing stages could not always be clearly carried out, as the descriptions in the sales figures are sometimes too vague or products with different processing levels were grouped together in one category. For example, the product group “cream cheese” contains both unripened cream cheese (which falls in processing stage 1) and cream cheese preparations (which falls in processing stage 5). The same problem occurred with the product group of frozen fish, which includes both unprocessed fish and fish fingers. In these cases, a justified assignment to a category was made.

[7] B.Sc. Thesis: Mielke S (2019) Verarbeitungsgrade der Bio - Lebensmittel im deutschen Naturkostfachhandel und dessen Verkaufsentwicklung zwischen 2016 und 2018 - Eine Untersuchung im Rahmen von ProOrg. FH Münster University of Applied Sciences, Department Food – Nutrition – Facilities.

Overall, most of the products were assigned to main group 4 “ultra-processed foods”, with “ready-to-eat” products in particular being frequently represented here. In a comparison of the years 2016-2018, an increase in sales volumes for level 1 and level 4 products was found. The increase in sales of level 1 products is mainly due to goat milk products and green asparagus. The increase in sales in Group 4 is primarily due to the fast food, marzipan, broth, and ready-to-use sauces product groups.

4.2.2 Analysis of the BIOFACH product innovation lists

The BIOFACH is an annual international trade fair for organic products. For several years now, the trade fair showcases new products submitted for display in the Novelty Product Exhibition and product innovations, providing lists of these for visitors. The application to order a product space for the novelty stand is voluntary and the only conditions are market entry time point and organic quality, therefore the data offer an exploration opportunity only. The BIOFACH novelty brochures from 2014, 2016, 2017, 2018 and 2019 has been examined[8] for the frequency of occurrence of highly processed foods according to the NOVA classification system (UPP, level 4). The composition of the product innovations was determined by means of a search on manufacturers’ websites. Only 10% of the products listed in the novelty lists were no longer found on the market. The products have been examined on the basis of their list of ingredients to determine whether they could be allocated to the category ultra-processed products (UPP). The product innovations classified as UPP were counted. According to our analysis the number of UPPs in the novelty brochures increased in the period under review (from 86 in 2014 to 118 in 2019). Most UPPs belong to the “snacks and sweets” group, while UPPs have the lowest proportion in the group of frozen goods. The UPPs represented in the latter group are ice creams, which are assigned to the UPPs due to the ingredients carob gum and guar gum. When it comes to fresh products, it is mainly milk and meat substitutes that fall into the UPP category. A visiting to the BIOFACH 2019 in Nuremberg suggests that microplastic is a recent, important trend in food processing. Plastic is in focus mainly as a packaging material, but also a contact material for food products during food processing and can therefore be a source of contamination.

4.3 Proportions of processed and non-processed organic food

Due to the challenges of finding appropriate data and the lack of combining sales data with stages of processing in general, no answer overall can be made regarding the ratio between organic and non-organic processed food sales. However, for the data presented above, a relation can be given for at least some products.

For organic milk in Germany, UHT-milk captured 17% of total organic milk consumption, while ESL-milk captured 57% and traditionally pasteurized milk 26% in 2014. In 2018, this relation has changed to 23% UHT-milk, 53% ESL-milk and 24% traditionally pasteurized milk.

[8] B.Sc. thesis: Sauer LM (2020) Welchen Verarbeitungsgrad nach NOVA-Klassifikationssystem haben die Produkte der Biofach-Neuheitenliste? Eine Untersuchung im Rahmen des Forschungsprojekts ProOrg. FH Münster University of Applied Sciences, Department of Food – Nutrition – Facilities.

For fruit juice, the data from Germany only describe the amount of pure fresh juice and juice from concentrate on the total fruit juice market. In 2014, 6% were pure fresh juice and 1% juice made from concentrate. In 2017, this changed to 7% pure fresh juice and 1,6% juice made from concentrate. The relation stayed nearly the same.

For France, there is no comparable data available, but for Italy, a comparison of some products is possible. In 2016, fresh milk made up 2,98% of the whole organic shopping basket. This percentage decreased to 2,87% in 2018. At the same time, the share of UHT milk in the whole organic shopping basket rose from 0,46% to 0,8%. Fresh cream had 0,02% of the whole organic shopping basket in 2016 and 0,01% in 2018, while UHT cream had 0,08% in 2016 and 2018. While the amount of fresh pesto decreased from 0,21% in 2016 to 0,17% in 2018, the amount of UHT pesto increased from 0,09% to 0,17%. For bread, this trend was the other way round. In 2016, 0,79% of the whole organic shopping basket was packaged sliced bread and only 0,02% fresh bread. This changed to 0,68% for packaged sliced bread and 0,04% for fresh bread in 2018. For fruit juice, the pure fresh juices and juices made from concentrate had 0,51% in 2016 and 0,66% in 2018. While at the same time the even more pure fresh fruit juice decreased from 0,62% to 0,51%.

It is not possible to derive general trends from this data. There seems to be an increase in UHT milk in organic quality at least in Italy and Germany, and some more juices made from concentrate in Germany. The total consumption of organic food increased in general, so this has to be considered when looking at the data. The underlying reasons for the changes are not in evidence and may range from changing consumer demographics to changes in relative volumes of products on the market.

5. Processing aspects of organic food in product communication

5.1 Declaration of processing methods on organic food packaging

In the Winter of 2018 field research on the declaration of processing methods on food packaging took place in seven supermarkets in Muenster, Germany. A total of 105 students[9] researched milk, fruit juices and tomato passata that bore claims about the processing methods on the product packaging. Both non-organic and organic products have been examined. After deleting doublings, 33 fruit juices (organic: 13, non-organic: 20), 36 milks (organic: 16, non-organic: 20) and 13 tomato purees (organic: 8, non-organic: 5) remained. Translations of declarations are our own.

In every product group, non-specific terms of careful processing could be found describing the processing method, e.g. “gentle”, “careful” and “love” (milk: 15, juice: 13, tomato puree: 22). Fruit juices and tomato passata were promoted with time-associated terms, such as "bottled directly" or “fresh from the tree” (fruit juice: 23, tomato puree: 6). 26 juices were direct juices, 7 were made from concentrate. Milk was promoted by means of the missing processing steps: nine milk varieties were promoted with the information that the product has *not* been microfiltrated or homogenized. Few technical details were indicated (temperature or duration of heating). An obvious contrast between organic and non-organic products was not found within this research.

These findings suggest that producers prefer emotive over objective terms about minimal or gentle processing for promoting their products. But they do not state clearly what exactly is meant with the term gentle in processes such as pasteurizing milk or pressing fruits to juice. Moreover, it is not clear what consumers’ response to the description of food processing is.

A more comprehensive investigation about the communication of food processing methods was carried out by Borghoff et al. (2019) whereby a comparison was made between German and Polish milk packaging (organic and non-organic) in supermarkets in Muenster, Germany and Warsaw, Poland. The focus in the text information was not on processing issues, but on the types of quality issues found on the packaging. The sample included 98 items in Germany and 52 items in Poland. Analysis showed that external quality parameters (traceability, regionality, environmental aspects, animal welfare) were used more often than internal ones (taste, effect on health). The three most frequently mentioned quality aspects on the German packaging were *feed without genetic engineering*, *animal welfare* and *quality promise*, while the three most frequently mentioned quality aspects on the Polish packaging were *local*, *quality promise* and *feed without genetic engineering*.

In a wider survey, a similar comparison with milk packaging (exclusively organic) from Germany (n = 37), Poland (n = 13), the Netherlands (n = 27) and Italy (n = 16) was undertaken. In the study, too, *animal welfare* and *local* were among the most frequently cited information on quality. Information on GMO-free packaging was often found on German packaging, while information on environmental friendliness was often found on Italian and Dutch packaging. Quality promises were most often found on Polish packaging.

[9] By B.Sc. degree programme students of the courses (labs) Ernährungsökologie and Nachhaltige Gemeinschaftsgastronomie at FH Münster University of Applied Sciences, Department of Food – Nutrition – Facilities.

5.2 Communicating processing methods on product packaging

Screening of product packaging for milk, fruit juice and tomato products have been carried out using a product inventory approach in supermarkets and discounters in the city of Muenster, Germany, in the summer of 2019.

5.2.1 Processing on product packaging of milk

Eight supermarkets and discounters have been visited in Muenster[10], including a wholly organic supermarket. A photo documentation of the packaging was made from the milk range for each milk item. Table 40 indicates the milk types documented in this way. The milk cartons were examined to see what information was given about the processing method. The information was divided into categories and the frequency of mentions in the individual categories was recorded.

Table 40 Overview of the different types of milk examined

	Pasteurized milk	ESL milk	UHT milk	Total
organic	8	15	14	37
non-organic	5	28	28	61
total	13	43	42	98

Detailed information on the heating process with temperature and time is only given by one manufacturer who offers pasteurized milk and ESL milk. No information on technical details (temperature, time, pore size of the filter, etc.) was found on ESL milk packaging. Pasteurization is described by the term “traditional”. The production of ESL milk (microfiltration) is described several times as a "special process" in which the "valuable ingredients are retained". Homogenization is indicated on all homogenized milk, this being a voluntary statement. The term “gentle” is used for milk at all processing stages to describe the processing process. Here it does not matter whether the different heating processes, the omission of homogenization or the processing is meant in general. The term “carefully” is used less often and was only found on ESL and UHT milk. Information about free-from genetic engineering was particularly frequent on the milk packaging, for example using the “Ohne Gentechnik” label or in text form. Other frequently used terms are “natural” (23 finds), “quality” (31 finds), “fair” (21 finds), “species-appropriate” (18 finds). An obvious difference between organic and non-organic milk items was not found.

5.2.2 Processing issues on product packaging of fruit juice

An inventory took place in 7 supermarkets and discounters in Muenster[11], including a purely organic supermarket. A photo documentation of the packaging has been made for each fruit juice of the fruit

[10] M.Sc. project: Elsner F (2019) Marktuntersuchung über die Bewerbung biologischer und nicht biologischer Trinkmilch im Rahmen des CORE-Organic Forschungsprojektes ProOrg. FH Münster University of Applied Sciences, Department of Food – Nutrition – Facilities.

[11] B.Sc. thesis: Seyberth NM (2019) Eine Marktuntersuchung über die Informationen zur Verarbeitung auf den Verpackungen biologischer und nicht biologischer Fruchtsäfte im Rahmen des CORE-Organic Forschungsprojektes ProOrg. FH Münster University of Applied Sciences, Department of Food – Nutrition – Facilities.

juice range. 201 non-organic juices and 79 organic juices were documented. Table 41 shows an overview of the documented products. The juice packs were examined to see what information was given about the processing method. The information was divided into categories and the frequency of mentions in the individual categories was examined.

Table 41 Overview of the examined fruit juices

Organic fruit juices	Non-organic fruit juices	total
79 (2 out of 79 from concentrate)	201	280

A reference to the prohibition of use was only found on one organic juice and was not used on any of the other juices. Pasteurization was specified for 50 juices, for the non-organic juices a “gentle short heat treatment” was specified on 7 packages and “gentle pasteurization” on 13 packages. The term “gentle” is used to describe processing (5 organic, 1 non-organic), pressing (5 organic, 2 non-organic) and filling (8 organic, 0 non-organic). The claim “freshly pressed” was used on 10 organic juices and 12 non-organic juices.

5.2.3 Processing issues on product packaging of tomato products

To survey tomato products 9 supermarkets and discounters have been visited in Muenster[12], including a purely organic supermarket. From the assortment of processed tomatoes, a photo documentation of the packaging was made of each variant. All tomato products with a tomato content of over 90% and which did not undergo any additional processing steps such as evaporation have been included in the investigation. The products examined are canned tomatoes with whole or chopped tomatoes and tomato sauces. Table 42 shows an overview of the products examined. The packaging was examined to see what information was given on the product and processing methods.

Table 42 Overview of the tomato products examined

Organic tomato products	Non-organic tomato products	Total
42	66	108

Frequently used terms to describe the products are "sun-kissed" and "sun-ripened" to describe the raw material. The processing is often described with terms such as “freshly harvested”, “freshly processed” or “directly after harvest”. The terms “gentle”, “carefully” and “handpicked” were found on 24 products, the expression “with love” was used on 18 products. There was an indication of pasteurization on 2 non-organic products’ packaging. Information on raw materials and harvest methods dominated the information on processing. An obvious difference between organic and non-organic products was not found.

[12] M.Sc. project: Döllefeld D (2019) Marktuntersuchung über die Bewerbung des Verarbeitungsgrades biologischen und nicht biologischen Tomatenpürees im Rahmen des CORE – Organic Forschungsprojektes ProOrg. FH Münster University of Applied Sciences, Department of Food – Nutrition – Facilities.

Food producers predominantly use verbal information to describe the food processing. Within the field research, there were no examples of packages with pictures of industrial food processing. The pictures on the packaging mostly show the raw material (fruits, whole tomatoes, cows on grassland). Information on the processing method is given via verbal claims. Emotive descriptions outweighed technical descriptions.

5.3 Processing-related information on the packaging required by legislation

For all EU member states, the underlying principles of the information for consumers are defined in the regulation (EU) No 1169/2011 of the European Parliament and of the council of 25 October 2011 on the provision of food information to consumers, amending Regulations (EC) No 1924/2006 and (EC) No 1925/2006 of the European Parliament and of the Council, and repealing Commission Directive 87/250/EEC, Council Directive 90/496/EEC, Commission Directive 1999/10/EC, Directive 2000/13/EC of the European Parliament and of the Council, Commission Directives 2002/67/EC and 2008/5/EC and Commission Regulation (EC) No 608/2004. Process related information is written down in Annex VI Part A. Following this, "*the name of the food shall include or be accompanied by particulars as to the physical condition of the food or the specific treatment which it has undergone*", so the consumer cannot be misled by the name of the product. The regulation gives powdered, refrozen, freeze-dried, quick-frozen, concentrated, and smoked as examples. Defrosted products must have the hint of defrosting with them, except when freezing is a necessary step or when defrosting has no negative effect on the safety or quality of food. Foods that are treated with ionizing radiation must bear the terms "irradiated" or "treated with ionizing radiation". Hydrogenated fat must bear the claim "fully" or "partly hydrogenated" (Annex VII Part A).

The EU regulation must be transferred into national law by every member state of the EU. In ***Germany***, this is done by the Regulation on the implementation of EU legislation concerning consumer information on food (Lebensmittelinformations-Durchführungsverordnung - LMIDV).

5.3.1 Fruit Juice

For fruit juice, within the EU there is the council directive 2001/112/EC of 20 December 2001 relating to fruit juice and certain similar products intended for human consumption. Consumers must be informed about the following process-related information:

- Mixture of fruit juice and fruit juice made from concentrate
- If the juice is made from concentrate
- Addition of vitamins and minerals
- Added sugar, acidifying agents
- Addition of extra pulp or cells

The regulation for ***Germany*** is the Fruit Juice and Soft Drinks Ordinance of 24 May 2004 (BGBl. I p. 1016), which was last amended by Article 12 of the Ordinance of 5 July 2017 (Federal Law Gazette I p. 2272). This regulation is like the 2001/112/EC, except that the ingredients to restore fruit juice made from concentrate do not have to be on the packaging.

Fruit products processed with high pressure (High Pressure Pasteurization) are listed in the *COMMISSION IMPLEMENTING REGULATION (EU) 2017/2470 of 20 December 2017 establishing the*

Union list of novel foods in accordance with Regulation (EU) 2015/2283 of the European Parliament and of the Council on novel foods. Fruit products processed with high pressure need a claim on the packaging about this treatment (COMMISSION DECISION of 23 May 2001 authorising the placing on the market of pasteurised fruit-based preparations produced using high-pressure pasteurisation under Regulation (EC) No 258/97 of the European Parliament and of the Council (notified under document number C (2001)1462)).

5.3.2 Milk

In ***Germany***, the information on packaging of milk is regulated in the milk labelling regulation (Milchkennzeichnungsverordnung). On the packaging, there must be information on the heat treatment the milk has gone through. Milk is either fresh milk or UHT milk (ultra-high temperature treatment). Fresh milk includes milk that has been traditionally pasteurized or is fresh milk with extended shelf life (ESL). ESL milk must be marked with the expression "extended shelf life" ("länger haltbar"). Since 2007, information on the homogenization of milk is not mandatory anymore. (BMEL 2013)

5.4 Food processing methods in video and website promotion

According to a study by the organisation *Lebensmittelklarheit*, producers use claims and images such as "artisanal" or "like home-made" for promotion; however, this has nothing to do with real food processing in industry (Zuehlsdorf & Spiller 2012a, pp. 39-41). Such promotion can be conveyed by many channels beyond product packaging. One important channel for communication from producers are **videos** used for information about their products but also for advertising and public relations purposes. These videos can be shown on television and via the internet. On the platform *youtube*, for example, several food processors have own channels, where they upload advertising videos from television and also more detailed image films.

In summer 2019, 23 freely available advertising videos and image films of fruit juice producers and producers of dairy products have been analysed[13]. A total of 10 advertising videos each on fruit juice and milk were analysed regarding statements about processing and on how food processing is described in the videos. The set of videos from producers included some from those with certified organic products (4 videos from 4 fruit juice producers; 7 videos from 5 milk and dairy producers) and some from those without certified organic products (6 videos from 4 fruit juice producers; 3 videos from 1 milk and dairy producer).

First, the videos have been transcribed and the transcripts were then examined to see how the processing of the raw materials is presented. In addition to the language contributions, visual aspects, such as the setting (e.g. heating milk in the kitchen at home), have been included too.

In the promotional videos of both product groups, idyllic depictions of cultivation and production predominate. A combination of traditional and modern methods is often emphasized. The reference to the place of origin is also emphasized. The terms “gentle”, “carefully” and “fresh” are used equally.

[13] by M.Sc. degree programme students in the elective Sustainability & Marketing at FH Münster University of Applied Sciences, Department of Food – Nutrition – Facilities.

There is a focus on hands in the videos on fruit juice. Both in the picture, hands are often in the centre and also linguistically in terms such as "hand-picked". Three videos show the chopping of the fruit, the others show a change from the whole fruit to the finished juice.

In the milk videos, heating is only shown in a private kitchen; the industrial processing of milk is indicated by showing systems, filling into bottles, and checking in a laboratory, but not explained in more detail. Processing often is not described in detail. Only one video showed the pressing of a fruit and no explanation was given. Regarding dairy products, the focus of the videos was on the welfare of the cows most of the time. Only one producer used the heat treatment of the milk for promotion (Weihenstephan). The message of this producer is that their UHT milk has the same taste as pasteurized milk because of their gentle treatment.

Another channel for advertising and communication is the internet, with open access **websites** of the food processors. Therefore research took place using the homepages of food processors, with a focus on dairy products and fruit juices (see also Borghoff & Strassner, 2019).

Initially research took place on the respective websites of the ten biggest dairy processors in Germany i.e., DMK Deutsches Milchkontor, Unternehmensgruppe Theo Müller s.e.c.s., Hochwald Foods GmbH (Bärenmarke), Arla Foods GmbH, Hochland SE, Friesland Campina Germany GmbH, Fude + Serrahn Milchprodukte GmbH & Co. KG, Zott SE & Co. KG, Bayernland eG, Meggle AG (Milchindustrie-Verband e.V. 2018). On these websites, no information on processing issues have been found, so research was extended to the brands of these dairy processors and other German dairy processors not in the list. Focus was laid on processors that produce **drinking milk**.

On their website, *Landliebe* (Friesland Campina Germany GmbH) presents the path of milk until it is filled in packages. At one side of the website, the heat treatment of the milk is presented. Information about the homogenization could not be found on the website.

Molkerei Weihenstephan GmbH & Co. KG describes the processing of the milk to different products in detail and without images. The controlling of the fat content as well as homogenization are described, also the heat treatment. The website differentiates between UHT milk and fresh pasteurized milk, but not fresh milk with extended shelf-life. There is no detailed or specific information on temperatures.

Onken (Emmi Deutschland GmbH) presents information about the production of their yoghurts on their website. They give the short information that their pasteurization of the raw milk is gentle. No further information could be found.

At the website of *Muellermilch* (Unternehmensgruppe Theo Müller s.e.c.s.) a video that explains the processing of the milk. Within this video, the processing is explained in detail, the cleaning and separation of the milk, the homogenization, and the heat treatment of the milk.

The *Andechser Molkerei Scheitz GmbH* presents a video on the processing of their milk on their website. This video was part of the set analysed in the previous section.

On the website of the *Gläserne Molkerei GmbH* there is no extra chapter on the processing technologies. Only in the section where the products are presented can some information on milk processing be found.

On the website of *Milchwerke Berchtesgadener Land Chiemgau eG* there is a section with FAQs. Here, also information on heat treatment and homogenization are given. Pasteurization is described with reference to temperature and time, homogenization is just mentioned and not explained. (Milchwerke Berchtesgadener Land Chiemgau eG n.d.)

The research was extended on the four biggest dairy producers in Switzerland: *Emmi*, *Cremo SA*, *Hochdorf* and *Elsa* (Schweizer Milchproduzenten SMP Genossenschaft 2017). *Hochdorf* does not show drinking milk within their product portfolio (Hochdorf Holding AG no date). *Emmi* and Cremo SA do not show information on processing on their homepages (Emmi n.d.; Cremo SA 2019), while *Elsa* describes milk processing.

Described are the centrifugation and homogenization of the milk, pasteurization, and ultra-high-temperature treatment of the milk, with reference to time and temperature (Elsa 2019).

In Germany, the interests of **fruit juice** producers are represented by the *Verband der deutschen Fruchtsaftindustrie e.V.*, the association of the German fruit juice industry of which most of the German fruit juice processors are members (VdF 2013). The website of the VdF presents a detailed overview of the production of fruit juice, direct juice as well as juice made from concentrate. The production is described in detail, with reference to time and temperature of the heat treatment.

The websites of the four biggest fruit processors in Germany, E*ckes-Granini, Refresco, Riha-Wesergold* and *Valensina* (Statista 2019), have been analysed for information on food processing. While on the website of *Eckes-Granini* and *Refresco* no such information could be found (Eckes-Granini Deutschland GmbH no date; Refresco Deutschland GmbH no date), the website of *Riha-Wesergold* showed some information and explained what direct juice is (riha WeserGold Getränke GmbH & Co KG no date). Most information on processing could be found on the website of *Valensia*. Here, there were own chapters explaining the processing of different fruit juices (direct juice, cool and ambient as well as fruit juice made from concentrate) (Valensina GmbH 2019). Furthermore, there were videos on the website that explained the processing (these are part of the set analysed in the previous section).

5.5 Consumer organisations on general and organic food processing

5.5.1 Publications by consumer organisations on food processing methods

Some consumer organisations and consumer protection agencies publish material on food processing issues in general, and sometimes for organic food. Research in **Germany** showed that no publications about processing in general have been made available by the German Nutrition Society (Deutsche Gesellschaft für Ernährung (DGE)), by the consumer watchdog *foodwatch* or the consumer bureau Verbraucherzentrale.

The *Verbraucherzentrale* published some articles about irradiation, highly processed meat (possibly carcinogenic) and milk processing. (Verbraucherzentrale 2015, 2019a, 2019b)

The *Landfrauenverbände* (organizations for women living and working in agricultural contexts) work in part on consumer education with a strong focus on home economics. This organization can be found in most rural parts of Germany. Most of the branches contacted do not have food processing

as a main topic. Only the Hessian *Landfrauenverband* told us that they give the advice to use minimally processed products.

The *Federal Centre for Nutrition* has a blog on their website, named "Was wir essen" (English: What we eat). On this platform, food experts tell stories about food and nutrition in an informal way to inform and entertain consumers. On the website and within the blog, some articles about processing can be found. There is one article about the trend "de-processing", which means that convenience products with less additives should be preferred (Icking 2018). Other articles focus on single processing methods, such as canning (Reme & Maschkowski n.d.; Pulg 2018), freeze-drying (Menn n.d.; Icking 2019), sulphurising (Pulg 2017) and milk processing (Rösch, Illini and Icking n.d.; Rösch n.d.; Icking 2016).

A study by Zuehlsforf and Spiller (2012b) suggests that new technologies need more regulations for advertising, e.g. moulded meat; consumers do not know what is meant by the terms. Furthermore, food is often promoted with claims about traditional processing. This leads to consumers feeling fooled when they find out that the production is not traditional.

The *Union Fédérale des consommateurs* is the biggest consumer protection organization in **France**. In 2019, they published an article about the negative impact on health of ultra- processed products, or "aliments ultra-transformés" (AUT) (Calasegno 2019). The article uses information from the Santé study but highlights also possible biases. The reduction of consumption of ultra-processed products and preference of raw products is part of the French dietary recommendations (Calasegno 2019).

In the **Netherlands**, consumers can find information on food and other products of daily life at the website of the *Consumentenbond*. On their homepage, they give general information on food and nutrition and have an own section for questions about E-numbers (Rolvink 2018). However, information about food processing in general was not found. An email query remained unanswered.

The **Swiss** *Stiftung für Konsumentenschutz*, a private organization for consumer protection, published a quality charta for food (Stiftung für Konsumentenschutz 2012). They highlight that a high grade of processing leads to anonymous products. Consumers cannot identify the quality of the product when it is highly processed. This, it is explained, is the reason why products should be natural.

In the **European Union** the *European Public Health Alliance* (EPHA) did no original research on processing. Also, the *European Consumer Organisation* (BEUC) was contacted about past published statements on food processing. However, BEUC did not publish any statements especially on processing, but gives the advice to prefer minimally processed food with as little additives as possible. Also contacted via email have been the national consumer protection organizations form Poland (Federacja Konsumentów ul. Ordynacka), Denmark (Forbrugerrådet Tænk), Italy (Altroconsumo), and Hungary (Országos Fogyasztóvédelmi Egyesület), but no answers have been received.

5.5.2 Evaluation of food processing in two German consumer watchdog magazines

A thesis in Germany[14] examined which criteria the consumer magazines *Stiftung Warentest* and *Oekotest* use to evaluate processed foods. The work was limited to articles on dairy products, juices,

[14] B.Sc. thesis: Mohammadkhani S (2020) Wie werden Milch, Fruchtsaft und Tomatenprodukte von Verbraucherschutzorganisationen bewertet? Eine Beitragsanalyse der Zeitschriften Stiftung Warentest und Öko-Test im Rahmen von ProOrg. FH Münster University of Applied Sciences, Department of Food – Nutrition – Facilities.

and processed tomatoes from the past 10 years. Specifically, tests of milk, orange juice, vegetable juice, tomato ketchup and strained tomato products were examined. The oldest test is from 2009. The test criteria have been determined and are summarized as follows in Table 43 for orange juice, Table 44 for milk and Table 45 for tomato products.

Table 43 Criteria used by two German consumer watchdog magazines for an evaluation of orange juice products

Criteria for the examination in general (Oekotest and Stiftung Warentest)	Criteria for the examination concerning Corporate Social Responsibility (CSR) (Stiftung Warentest)
- Label for responsible production: guaranteed minimum price, ILO core labour standards, ban on highly hazardous pesticides, independent control; if there is no label, there is a devaluation of 4 grades; the EU organic seal, the seal of the Rainforest Alliance and the Demeter seal lead to a deduction of 2 marks; a mark is deducted from conventional products that carry the fair trade seal - Ingredients: vitamin C content, pesticides - Sensory, aroma quality - Chemical quality (volatile acid, ethanol, D- and L-lactic acid, hydroxymethylfurfural, pesticides) - Other defects - Packaging: light protection, material labelling, recycling / deposit information, handling - Declaration: legibility, nutrition labelling, storage information, advertising messages	- Plantations (30%): traceability, working conditions, environmental protection, on-site visit - Company policy (20%): CSR strategy, socio-ecological working conditions, service for consumers - Washing / pressing / concentrating / cooling (20%): social benefits, health promotion, plant protection, ecological requirements - Bottling (20%): working conditions, environmental protection measures - Transparency (10%): Participation in the survey, readiness for audits

The orange juices examined were not-from-concentrate juices as well as juices from concentrate, with and without pulp. There was no devaluation for juices made from concentrate due to the production method. *Oekotest* awarded high deductions for missing labels or the use of labels with low social and production standards (including the EU organic logo and Demeter). Most juices did not do well in the CSR examination by *Stiftung Warentest*; organic and Fairtrade products also received deductions for lack of evidence and inadequate controls as considered by the judging panel.

Criteria for the examination of vegetable juice as used by *Oekotest* included

- Sensory analysis
- Ingredients: sugar content, added honey, nitrate content, benzene content (carrot juice)
- Packaging: material and information

The juices examined were carrot, beetroot, and sauerkraut juices in organic and non-organic quality. The evaluation of the ingredients forms the basis of the overall rating, while the sensory and packaging can only contribute to an appreciation or depreciation. A high salt content in sauerkraut juice and the addition of honey in carrot juice mean that the juice can only be rated as "good".

Table 44: Criteria used by two German consumer watchdog magazines for an evaluation of milk products

Criteria for the examination in general (Oekotest and Stiftung Warentest)	Criteria for the examination concerning CSR (Stiftung Warentest)

- Ingredients: fat content in accordance with the information on the packaging, content of BAC (disinfectant residue); Omega-3 fatty acids
- Sensory analysis
- Feed:
  o Green fodder (typical fatty acid pattern)
  o GMO-free
- Protection of ingredients during heat treatment: comparison of marker ingredients with praise
- Critical substances: halogenated hydrocarbons, aflatoxin M1, (per) chlorate, lead, antibiotic residues, iodine
- Microbiological quality
- Packaging: handling, recycling information
- Declaration: advertising statements, graphic representation, nutritional information, clarity
- Evidence and certificates: renunciation of genetic engineering, evidence of grazing
- The statement that the milk is regional is devalued if the catchment area extends over 100km
	- Traceability (0%): Checking documents such as delivery notes to the respective milk producers
	- Company policy (10%): social and ecological company guidelines, sustainability reports, goals for animal and environmental protection
	- Animal welfare (45%): purchasing guidelines, requirements for keeping animals, feeding, cow comfort, grazing
	- Environment (25%): procurement guidelines, management systems, climate and soil protection and biodiversity, documentation and training
	- Pricing, Transparency (20%): Disclosure of prices from suppliers, dairies, and farmers; Height of the producer price

Various organic and conventional drinking milk types were examined for milk. In the CSR test, the organic products performed better than the conventional products. They did better in particular in terms of animal and environmental protection, transparency, and the producer price.

Table 45: Criteria used by two German consumer watchdog magazines for an evaluation of tomato ketchup products and strained tomato products

Criteria for the examination in general (Oekotest and Stiftung Warentest for tomato ketchup)	Criteria for the examination in general (Oekotest for strained tomato products)
- Ingredients: quality of raw materials, flavours, flavour enhancers, sugar content, table salt content, ergosterol, ergosterol, lycopene content, carbohydrate content - Sensory judgment - Chemical quality: dry matter content, ash, sand, total acid, pH value, density - Pollutants: pesticides, parameters for unripe tomatoes (Solanine, Tomatine), heavy metals, mould toxins - Microbiological quality - Packaging: PVC / PVDC / chlorinated plastics lead to devaluation, handling, residual emptying, filling quantity, recycling information - Declaration: allergens, clarity, packaging and sensory information, tomato and tomato paste content, no use of genetically modified organisms (GMO)	- Ingredients: spoilage-promoting germs, lycopene content - Packaging: PVC / PVDC / chlorinated plastics lead to devaluation

Both conventional and organic tomato ketchups have been examined. The organic tomato ketchups contained a high proportion of lycopene (a substance giving the red pigment to some fruits and vegetables and valued for its potentially protective antioxidant capacity); In contrast to conventional ketchups, no traces of pesticides have been found in any organic ketchup. Both organic and conventional strained tomato products have been examined by the magazines; Here, too, as with vegetable juice, the focus is on the ingredients.

5.6 Consumer opinions on food processing methods and product qualities

The basis for this section is a literature review. The platform *Lebensmittelklarheit* is managed via the German consumer agencies and has the aim to help consumers that feel fooled by the food industry. When it was introduced to the public sphere, there was scientific research in parallel to examine the consumer opinion on food declaration and the terms used for food promotion (Zuehlsdorf & Spiller 2015). One finding from this study is the importance of freshness for consumers, that they linked this with a high product quality and a short distribution chain (in terms of time and path). The consumers thought that a fresh product is as natural as possible, and they reject fresh products having an extended shelf-life. Problematic is the fact that milk with an extended shelf-life (ESL-milk) in Germany is named "fresh milk", but for consumers, fresh milk is raw or only traditionally pasteurized. (Zuehlsdorf & Spiller 2015, pp. 19-20)

Nowadays on the website *Lebensmittelklarheit* consumers have the possibility to ask questions about food products in this public arena. In 2019, the authors of *Lebensmittelklarheit* gave an explanation on the often-used term "gentle pasteurized" for fruit juices. They stated that there is no difference between a gentle and a normal pasteurization because the method is fixed. (Lebensmittelklarheit 2019)

The *European Food Information Council* (EUFIC) did an online survey in UK on the consumer opinion about processed food in 2016 (EUFIC 2016). The 71 participants were from the ages 18 to 65 years and with different ethnic and educational backgrounds. The participants rated a food less healthful, the more it has been processed and vice versa. This result is similar to the findings of Szocs and Lefebvre (2016), where consumers associated a lower level of processing with more health benefits (a less processed product is healthier than a higher processed product: orange -> orange juice -> dried orange snack) and that they called "Blender effect". In the survey of EUFIC, only for dairy products was no correlation found between the perceived level of processing and healthfulness. However, the participants not only stated negative effects of processing. As benefits they listed the following points:

- Preservation and extended duration, product lasts longer
- Convenience, ready and faster to eat, no or little preparation for the end user
- Cheaper than fresh stuff, reduced cost
- Sensory enhancement
- Increased variety
- Increasing safety

As benefits of processing the participants stated that it makes food edible and last longer, also the quick preparation time was raised. In general, they stated that food loses nutritional value via processing and that they did not trust improved nutrition.

The participants also raised concerns about the food industry itself. They stated that they do not understand what is going on in food industry and that they often do not know what the ingredients of processed foods are. However, after they were provided with information on food processing, they were much more open towards the processing.

With processed foods, many participants connected fat, sugar, salt, and additives and this all with the term "unhealthy".

The participants demonstrated partial understanding of the array of processed foods, but food processed with traditional techniques often were unprocessed to them. The more positive view on traditionally processed foods fits with results from former research (von Alversleben 2001).

In 2005, Cardello, Schutz & Lescher (2007) examined the opinion of 79 military and 146 civil US-Americans on food processing technologies by means of a questionnaire. The potential risk of the technology like harmful by-products and unknown health risks were the most important factors for the participants to lower their interest in eating the food. The most negatively associated processing techniques were genetic modification and irradiation. In contrast, high pressure processing had the most positive utility, like heat pasteurization and cold preservation. The term "minimally processed" had a negative impact on the participants, because they linked it with insufficient processing and feared hygienic or other safety risks.

Consumers in general tend to prefer "natural" goods. Wilson (1984) calls this "biophilia" and explains that we have an innate desire for the experience of our ancestral environment (Wilson 1984; Rozin 2005). Biophilia can also be found in the domain of food, where natural goods are perceived as being healthier and better for the environment. Moreover, they are perceived better on a moral level. The concept of naturalness gets harmed when natural goods come into contact with unnatural entities ("contagion"). Also, naturalness is reduced by physical and even more by chemical transformation. Mixing of several natural entities does not harm their natural character, but genetic engineering does. (Rozin 2005) New food technologies raise a dichotomous thinking in most consumers with a negatively connoted technology side and a positive connoted organic / ethic side, but also trust in technology can be found (Bäckström et al. 2004). To measure the fear that people have about new food technologies, Cox & Evans (2008) developed the Food Technology Neophobia Scale (FTNS).

5.7 Market trends related to processed organic food

The basis of this research on innovations in processed food was data accessed via MINTEL, a global market research company. MINTEL collects information on new food and other daily life products worldwide via the method of mystery shoppers. The data (see Appendix B) has been studied for new organic products within the categories fruit juice, milk, and tomato puree for the last five complete years accessible (2014-2018) within the countries of the ProOrg consortium.

5.7.1 Fruit juice trends in selected European countries

General input data[15] and defined terms[16] were used as the research framework for the MINTEL database to study fruit juice registrations in ProOrg countries i.e., Denmark, France, Germany, Hungary, Italy, Netherlands, Norway, Poland, Slovakia, Sweden, and Switzerland.

There were 1.162 new registrations in the studied countries between 2014 and 2018. A bigger part, respectively 281 and thereby about half, was launched in 2016/2017. However, there were only 160 new registrations in 2014. The most used preparation claims by far over the years were *Puree* und *Made From Concentrate*. While the *Puree* claim initially increased until 2016, but significantly decreased after this year, the *Made From Concentrate* claim increased by trend between 2014 und 2017 with a slight decrease in 2018. The situation was similar for the *Concentrate* claim.

The high number of registrations of *Made From Concentrate* in 2017 is significant for Denmark. This claim was the most launched category in every other year as well. 2016 was the year with most new registrations in France, particularly in the *Puree*, *Concentrate* und *Made From Concentrate* categories. After 2016 the numbers of registrations decreased again. The decrease of new registrations of *Puree* between 2015 and 2018 is worth mentioning for the data from Germany. In total there was a decrease of new registrations as well. In Hungary there were only nine new registrations; most of them in the *Pulp*, *Made From Concentrate* und *Puree* categories. Meanwhile in Italy the new registrations of *Made From Concentrate* are increasing in trend, while the new registrations in the claim *Puree* increased significantly until 2016 and then decreased significantly as well until 2018. Nevertheless, *Puree* was in total obviously the most frequented claim. Most new registrations of fruit juice in the Netherlands were launched in the *Made From Concentrate*, *Puree* and *Concentrate* categories. For Poland the high number of new registrations in 2017 and 2018 and the diversity of claims in these years can be observed. The claim *Puree* increased significantly until 2016 and then decreased significantly as well until 2018 in Switzerland. Nevertheless, *Puree* was in total obviously the most frequented claim.

[15] **Date Published** is within the last five complete years
and **Claims** matches Organic as the claim
and **Ingredient Search** matches one or more of [Carbonated, Concentrate, Dry, Extract, Filtered, Fresh, Ground, Infused, Made From Concentrate, Pasteurised, Peeled, Pieces, Powdered, Pulp, Puree, Root, Sweet] as the Ingredients
and **Category** matches Juice Drinks

[16] **Concentrate** = The concentrated preparation tag involves removing the water of a previously existing product (like a juice or a puree) normally be heating it up, which evaporates the water. This can have some consequences as heat denatures proteins and so nutritional efficacy might be compromised.
Extract = Extracts are made by extracting a part of the raw material usually by one of four processes: Expression (separating the solid and liquid phases, with something akin to a sieve), absorption (soaking it in water to absorb the desired substances), maceration (physical manipulation, that can be like squeezing a lemon) and distillation (which uses selective boiling and condensation to separate the various components). These can then be sold as tinctures (if dissolved in ethyl alcohol), absolutes (concentrated oily mixtures) and powders (dried product of the extraction by removal of water). From these definitions a fruit juice would be a form of extract (usually by maceration).
Fresh = is usually and unprocessed product - for example fresh herbs as opposed to dried herbs.
Infusions = typically involve steeping the product in hot water to extract the desired molecules (just like teas)
Powdered and **Ground** = are both obtained from physical manipulation, usually something akin to a mortar and pestle, with ground being coarser (and usually less homogeneous). Both are typically dried.
Pulps and **Purees** = are preparations of the whole fruit/vegetable, and usually are obtained by maceration (physical manipulation) of the product, but not the same extent as in ground. They typically have some liquid still and may or may not be sieved.

5.7.2 Milk trends in selected European countries

General input data[17] have been used as the research framework for the MINTEL database to study milk in ProOrg countries i.e., Denmark, France, Germany, Hungary, Italy, Netherlands, Norway, Poland, Slovakia, Sweden, Switzerland.

Only 22 new milk products were new registered between 2014 and 2018. Most of them (8) were registered in 2014. The obviously bigger part (17) was *Pasteurised*. Only two products were *Micro-filtered*.

Three new registrations have been registered for Denmark in 2014, 2016 and 2018, respectively only *Pasteurised*. In France three new registrations with *UHT* have been identified in 2014 and 2017, two registrations with *Pasteurised* in 2015 and one new registration with *Micro-filtered* in 2018. Mentionable is the lack of registrations in 2016 for Germany. Otherwise there were a lot of new registrations in comparison to the other countries. Most of them were *Pasteurised* (9) and *Homogenized* (8). Only one registration was *Micro-filtered* in 2014 and one *UHT* in 2018. The search for new registrations in Hungary and in Italy matched no hits. There was only one new registration in the Netherlands with *Pasteurised* in 2018 and only one new registration in Poland with *Pasteurised* in 2014. There were only two new registrations in Switzerland with respectively *Pasteurised* and *Homogenized* in 2017.

5.7.3 Tomato puree trends in selected countries in Europe

Using the MINTEL database with specific input data[18] and defined terms[19], ProOrg countries have been selected for the study of tomato puree i.e., Denmark, France, Germany, Hungary, Italy, Netherlands, Norway, Poland, Slovakia, Sweden, Switzerland.

In total, 402 products have been identified between 2014 and 2018, which were connected with *Tomato Puree*. About three-quarter (299) of these products were made with *Concentrate*. Also mentionable were the claims *Double Concentrated* (68) und *Cooked* (51). The new registrations of products with *Concentrate* und *Double Concentrated* increased constantly between 2014 and 2017. *Cooked* were especially registrations in the years 2017 and 2018. The most different preparation claims (6) were also registered in 2018 (minor *Chopped*, *Filtered* und *Skinless* as well).

There were only 11 new registrations in Denmark (especially between 2015 and 2017) with the claim *Concentrate* and only two with *Skinless* in 2018. A clear trend in France is indicated with the

[17] **Date Published** is within the last five complete years
and **Claims** matches Organic as the claim
and **Ingredient Search** matches one or more of [Homogenized, Micro-filtered, Pasteurised, UHT] as the Ingredients
and **Sub-Category** matches White Milk (with **Format Type** matches Liquid)

[18] **Date Published** is within the last five complete years
and **Full text search** matches Tomato puree with word variants
and **Claims** matches Organic as the claim
and **Ingredient Search** matches one or more of [Chopped, Concentrate, Cooked, Double Concentrated, Filtered, Heat-processed, Heat Sterilised, Heat Treated, Skinless] as the Ingredients

[19] **Concentrate** = The concentrated preparation tag involves removing the water of a previously existing product (like a juice or a puree) normally be heating it up, which evaporates the water. This can have some consequences as heat denatures proteins and so nutritional efficacy might be compromised.
Concentrated purees and more are usually a version of the product with less water, and therefore with a more intense taste / scent and lighter so easier to transport / package.
Cooked = is a generic term, having only the meaning that it was heat-treated in some way (steamed, braised, boiled, grilled, etc).

claim *Cooked*. The new registrations increased over the years, while the new registrations with *Concentrate* increased until 2016, but also decreased again until 2018. A development similar to that for *Concentrate* can be observed for the claim *Double Concentrated*. The new registrations in Germany with *Concentrate* were the bigger part in Germany (more than three-quarters), whereas the development varied but exhibited no trend. The high number of new registrations are evident in 2017. In this year four claims had the highest number of registrations over the years. The search for new registrations in Hungary brought no hits. Italy, the mother country of pizza and pasta and the biggest producer of tomatoes within the EU, had only one new registration. The Netherlands had solely new registrations with *Concentrate* between 2014 and 2016. While they made the bigger part in total as well (25 from 29), there were three new registrations with respectively *Cooked*, *Double Concentrated* and *Chopped* in 2018. There were only new registrations with the claim *Cooked* in 2015 and 2016 (nevertheless, very little) in Poland. There were respectively three new registrations with *Concentrate* in 2017 and 2018. There were only a few new registrations in Switzerland. Nevertheless, the registrations increased over the years a little bit, particularly the number of different preparation claims.

6. Concluding remarks

Differentiating between foods that are processed over and above food group categories remains a challenging issue. There are a large number of classification systems for processed foods in academic literature and a few others applied in professional practice. These have each been developed with a specific aim in mind, such as providing nutrition guidance or organising foodstuff data. Most of those designed with consumer nutrition guidance as one aim take nutrients or substances in general as the main criteria. Only the NOVA system clearly takes processing techniques into account. However, these are not differentiated beyond the category industrial processing. Furthermore, none of the systems except Wholefood Nutrition (Vollwert Ernährung) take environmental or other impacts into consideration; these impacts are not quantitatively characterised. Organic production is addressed by these two systems only: the former specifically excludes it while the latter specifically recommends food products from organic production. Thereby neither takes organic food processing into detailed account. Hence, none of the described classification systems is appropriate for a deeper exploration of organic processed foods and a differentiation within these or between non-organic and organic processed foods. It could be shown that organic foods in the market cover all categories within processed foods classifications, including very highly processed foods categories. Given the increased attention paid to processing of foods and the connection with human health, as well as the general recommendation made by several private and national nutrition bodies to avoid very highly processed foods, the organic sector does need to address this issue. One avenue could be to build on existing classification systems and adapt these to include organic specifications or else to develop a new classification, drawing on organic principles and the organic perspective as a guiding framework. This might include more detailed criteria on sustainability-related impacts.

The legislation for organic processing of foods provides a general framework with guiding principles and permitted substances for processing; some few technologies are specifically mentioned and forbidden. The private standards of some organic associations provide more detailed guidance, though again, this is mostly limited to restriction of permitted substances and applications. The organic sector finds itself in a dynamic growth phase in the European Union and elsewhere. This is not only limited to organic farming production but also includes organic food production. The market analysis could not distinguish between processed foods effectively or at all, but overall it underlines the growth in processed organic foods entering the market year on year. Trends in the data studied suggest an increase in very highly processed organic foods. This development needs to be referred to the overall guiding principles for organic food and farming and addressed by the sector. Communication of processing-related aspects of organic products shows little differentiation to non-organic products. Both would seem to use vague terms and avoid professional processing visuals. Herein may lie a chance for better promotion of organic foods if unique organic processing attributes can be distinguished.

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Appendix A

Table 46 Permitted additives and processing for organic food processing

E nr.	Name	EU	Demeter (intl.)	Bioland	Naturland	Biokreis	Biopark	Gäa	Ecoland	Bio Suisse	Soil Association
E 120	Carmine									X	
E 153	Vegetable carbon	X		X						X	X
E 160b	Annatto, bixin, norbixin	X									X
E 170	Calcium Carbonate	X	X	X*	X	X	X	X*	X	X	X
E 220	Sulphur dioxide	X	X	X							X[A]
E 223	Sodium metabisulphite	X									X[A]
E 224	Potassium metabisulphite	X	X	X							X
E 225	Potassium sulphite		X								
E 250	Sodium nitrite	X			X	X	X	X	X	X	X
E 252	Potassium nitrate (saltpetre)	X			X	X	X	X	X	X	X
E 270	Lactic acid	X			X	X	X	X	X	X	X
E 290	Carbon dioxide	X		X		X	X	X	X	X	X
E 296	Malic acid	X									X
E 300	Ascorbic acid	X		X	X	X	X	X	X		X
E 301	Sodium ascorbate	X			X		X	X			X
E 306	Tocopherol rich extract (Vitamin E)	X									X
E 322	Lecithin	X	X	X	X	X	X	X	X	X	X
E 325	Sodium lactate	X		X		X	X	X			X
E 330	Citric acid	X		X	X	X	X	X	X	X	X
E 331	Sodium citrate	X	X	X	X	X	X	X	X	X	X
E 333	Calcium citrate	X	X[INT]	X	X	X	X	X	X		X
E 334	Tartaric acid	X	X**			X	X	X		X	X
E 335	Sodium tartrates	X	X**	X	X	X	X	X	X	X	X
E 336	Potassium tartrates	X	X	X	X	X	X	X	X	X	X
E 341 (i)	Monocalcium Phosphate	X									X
E 392	Extracts of rosemary (organic)	X			X					X	X
E 400	Alginic acid	X									X

E 401	Sodium alginate	X									X
E 402	Potassium alginate	X									X
E 406	Agar	X	X	X	X	X	X	X	X	X	X
E 407	Carrageenan	X									X
E 410	Locust bean gum	X	X	X	X	X	X	X	X	X	X
E 412	Guar gum	X	X	X	X	X	X	X	X	X	X
E 414	Arabic gum	X	X							X	X
E 415	Xanthan gum	X									X
E 418	Gellan gum (high-acyl form)	X									X
E 422	Glycerol	X									X
E 440 (i)	Pectin (non-amidated)	X	X	X	X	X	X	X	X	X	X
E 464	Hydroxypropyl methyl cellulose	X									X
E 500	Sodium carbonate	X	X	X	X	X	X	X	X	X	X
E 501	Potassium carbonates	X	X**	X	X	X	X	X	X		X
E 503	Ammonium Carbonates	X		X	X	X	X	X	X		X
E 504	Magnesium carbonates	X		X*		X*	X*	X*	X*	X	X
E 509	Calcium chloride	X	X		X	X	X	X	X	X	X
E 511	Magnesium chloride (nigari)	X	X	X			X	X	X		
E 516	Calcium sulphate	X					X	X	X		X
E 524	Sodium hydroxide	X	X	X	X	X		X	X		X
E 527	Ammonium hydroxide									X	
E 551	Silicon dioxide gel or colloidal solution	X									X
E 552	Calcium silicate									X	
E 553a	Magnesium silicate									X	
E 553b	Talc	X									X
E 901	Beeswax	X	X[DE]			X	X	X	X		X
E 903	Carnauba wax	X	X[DE]			X	X	X	X	X	X
E 904	Shellac									X	
E 938	Argon	X	X[INT]								X
E 939	Helium	X									X
E 941	Nitrogen	X		X		X	X	X	X	X	X

E 948	Oxygen	X		X		X		X		X	X
E 968	Erythritol	X									X
		53	23	25	22	27	29	31	27	29	53

* only allowed as a flowing agent for salt
** only allowed as a base for baking powder
[A] = see additions
[INT]= argon as an inert gas and calcium citrate for fruit and vegetable processing are only allowed by Demeter International but not by Demeter Germany
[DE] = bees and carnauba wax are generally allowed by Demeter Germany but limited to bread and milk products by Demeter international

Source: own table, based on (vgl. Biokreis e.V., 2016)(vgl. Bioland e.V., 2014)(vgl. Biopark e.V., 2016, p. 10)(vgl. Naturland e.V., 2018, pp. 11–12)(vgl. Gäa e.V., 2014, p. 11)(vgl. Naturland e.V., 2018, p. 11)(vgl. Ecoland e.V., 2009, p. 23)(vgl. Demeter-International e.V., 2018, pp. 10–15)(vgl. Bioland e.V., 2017)(vgl. Ecoland e.V., 2009, pp. 21–22)(vgl. Demeter-International e.V., 2018, pp. 29–32)(vgl. Biokreis e.V., 2015d)(vgl. Bioland e.V., 2016a)(vgl. Biopark e.V., 2016, pp. 18–20)(vgl. Naturland e.V., 2018, pp. 21–22)(vgl. Gäa e.V., 2014, pp. 26–27)(vgl. Naturland e.V., 2018, pp. 19–20)(vgl. Biokreis e.V., 2019)(vgl. Biopark e.V., 2016, pp. 35–37)(vgl. Gäa e.V., 2014, pp. 46–47)(vgl. Bioland e.V., 2016f)(vgl. Demeter-International e.V., 2018, pp. 44–49)(vgl. Demeter-International e.V., 2018, pp. 20–27)(vgl. Biokreis e.V., 2015e)(vgl. Bioland e.V., 2016d)(vgl. Naturland e.V., 2018, pp. 31–32)(vgl. Gäa e.V., 2014, pp. 37–38)(vgl. Biopark e.V., 2016, pp. 27–29)(vgl. Biokreis e.V., 2015c)(vgl. Bioland e.V., 2016e)(vgl. Naturland e.V., 2018, pp. 23–24)(vgl. Gäa e.V., 2014, pp. 39–40)(vgl. Biopark e.V., 2016, pp. 29–33)(vgl. Bioland e.V., 2016h)(vgl. Demeter-International e.V., 2018, pp. 33–35)(vgl. Biokreis e.V., 2015a)(vgl. Gäa e.V., 2014, pp. 30–31)(vgl. Biopark e.V., 2016, pp. 20–22)(vgl. Demeter-International e.V., 2018, pp. 52–54)(vgl. Naturland e.V., 2018, pp. 35–36)(vgl. Bioland e.V., 2016g)(vgl. Bioland e.V., 2016b)(vgl. Biopark e.V., 2016, pp. 38–39)(vgl. Gäa e.V., 2014, pp. 49–50)(vgl. Demeter-International e.V., 2018, pp. 33–35)(vgl. Biokreis e.V., 2015b)(vgl. Bioland e.V., 2016c)(vgl. Biopark e.V., 2016, pp. 22–27)(vgl. Biopark e.V., 2016, pp. 22–27)(vgl. Naturland e.V., 2018, pp. 17–18)(vgl. Gäa e.V., 2014, pp. 32–36)(vgl. Demeter-International e.V., 2018, pp. 39–44; Durchführungsbestimmungen VERORDNUNG (EG) Nr. 889/2008 DER KOMMISSION vom 5. September 2008 mit Durchführungsvorschriften zur Verordnung (EG) Nr. 834/2007 des Rates über die ökologische/biologische Produktion und die Kennzeichnung von ökologischen/biologischen Erzeugnissen hinsichtlich der ökologischen/biologischen Produktion, Kennzeichnung und Kontrolle, ABl. Nr. L 250 vom 18.09.2008, S. 1, 2008)(vgl. Bio Suisse, 2019, pp. 159–223)(vgl. Soil Association, 2018, pp. 60–68)

Additions:
Soil Association:
- Free SO_2 for all fruit wines, cider, perry and mead must not exceed 30mg/L
- You must not use sodium metabisulphite as an additive, including for crustaceans

Bio Suisse:
- Colourants that naturally occur in food and that are extracted by physical methods (Curcumin [E 100], Riboflavin [E 101], Carotinoids [E 160], Xanthophyll [E 161], Beetroot Red, Betanin [E 162], Anthocyan [E 163], Chlorophyll [E 140])
- No chemical colours, synthetical components as glue or coating agents

Table 47 Generally prohibited processing methods in organic food production according to selected guidelines

Demeter intl.	Bioland	Naturland	Biokreis	Biopark	Gäa	Ecoland	BioSuisse	Soil Association
Fumigation (except CO_2 and N_2)	Fumigation (except CO_2 and N_2)	Fumigation (except CO_2 and N_2)	Fumigation (except CO_2 and N_2)	Fumigation (except CO_2 and N_2)	Fumigation (except CO_2 and N_2)	Fumigation (except CO_2 and N_2)	Fumigation (except CO_2 and N_2)	
Microwaves	Microwaves	Microwaves	Microwaves	Microwaves	Microwaves	Microwaves	Microwaves	
Nanomaterials (man-made)	Nanomaterials (man-made)	Nanomaterials (man-made)	Nanomaterials (man-made)		Nanomaterials (man-made)			Nanomaterials (man-made)
Cell fusion technology	Cell fusion technology	Cell fusion technology					Cell fusion technology	
							Chemical alteration of food substances	

Source: own table based on (vgl. Bio Suisse, 2019, p. 163)(vgl. Bioland e.V., 2017, pp. 11–12)(vgl. Soil Association, 2018)(vgl. Biokreis e.V., 2016, p. 4)(vgl. Naturland e.V., 2018, pp. 9–11)(vgl. Biokreis e.V., 2016, p. 7)(vgl. Gäa e.V., 2014, p. 13)(vgl. Gäa e.V., 2014, p. 19)(vgl. Biopark e.V., 2016, p. 7)(vgl. Ecoland e.V., 2009, p. 22)(vgl. Biopark e.V., 2016, p. 11)(vgl. Bioland e.V., 2017, p. 39)(vgl. Ecoland e.V., 2009, p. 24)(vgl. Bio Suisse, 2019, p. 68)(vgl. Bioland e.V., 2016a, pp. 5–6)(vgl. Demeter-International e.V., 2018, pp. 10–11)

Table 48 Additives, processing aids, microorganisms, enzymes, and flavourings for the processing of milk and milk products in organic guidelines of German associations

Category	Demeter	Bioland	Naturland	Biokreis	BioPark	Gäa	Ecoland
Additives	Locust bean gum Guar gum Agar Pectin, non-amidated Calcium carbonate* Calcium chloride Smoke (from untreated woods)	Locust bean gum Guar gum Agar Pectin, non-amidated Calcium carbonate* Sodium hydrogencar-bonate* Trisodium citrate** Plant coal*** CO_2, N_2, O_2 Smoke (from untreated woods)	Locust bean gum Guar gum Agar Pectin, non-amidated Calcium carbonate* Sodium hydrogencar-bonate* Calcium chloride Trisodium citrate** Lactic acid Citric acid Smoke (from untreated woods)	Locust bean gum Agar Pectin, non-amidated Calcium carbonate* Sodium hydrogencar-bonate* Calcium chloride Trisodium citrate** Smoke (from untreated woods)	Locust bean gum Guar gum Agar Pectin, non-amidated Calcium carbonate* Sodium hydrogencar-bonate* Calcium chloride Trisodium citrate** Smoke (from untreated woods)	Locust bean gum Guar gum Agar Pectin, non-amidated Calcium carbonate* Sodium hydrogencar-bonate* Calcium chloride**** Trisodium citrate** Smoke (from untreated woods)	Locust bean gum Guar gum Agar Pectin, non-amidated Calcium carbonate* Sodium hydrogencar-bonate* Sodium citrate**** CO_2, N_2 Lactic acid
	* only for the production of sour milk cheese ** only for the production of cheese spread and processed curd cheese *** only for ashed goat cheese **** production of cooking and melting cheese						
Processing aids	Lactic acid (Fruit)acid Plant oils Beeswax Natural hard paraffin wax Micro-crystalline Wax Plastic films Filter material (asbes-tos- and chlorine-free) cellulose textiles Diatomite Bentonite Perlite	 Acid Plant oils Beeswax Natural hard paraffin wax Micro-crystalline Wax Plastic films	Not allowed	 Acid Plant oils Beeswax Natural hard paraffin wax Micro-crystalline Wax Plastic films	 Acid Plant oils Beeswax Natural hard paraffin wax Micro-crystalline Wax Plastic films	 Beeswax Natural hard paraffin wax Micro-crystalline Wax Plastic films Plant ash (for cheese production)	Lactic acid

	Activated carbon filter CO_2, N_2, O_2, Ar [x]						
	[x] as inert gas/processing aid for all product groups						
	Note: processing aids marked in grey are generally allowed for Demeter food production but not specifically named within this product specific part of the guideline						
Enzymes	Rennet	Rennet Lactase	Rennet Lactase	Rennet	Rennet	Rennet	No specification
Microorganisms	Common starter cultures (bred on organic substrates; no genetically engineered cultures)	Common starter cultures (bred on organic substrates; no genetically engineered cultures)	Common starter cultures (bred on organic substrates; no genetically engineered cultures)	Common starter cultures (bred on own substrates; no genetically engineered cultures)	Common starter cultures (bred on own substrates; no genetically engineered cultures)	Common starter cultures (bred on own substrates; no genetically engineered cultures)	No specification
Flavourings	Organic aroma extracts (etheric oils and pure extracts)	Only for milk products with fruit content: etheric oils and pure extracts (organic)	Only for milk products with fruit content: etheric oils and pure extracts (organic) Natural flavourings on approval	Natural flavourings and extracts only on special approval	Natural flavourings (if necessary) Organic or conventional aroma extracts only for fruit preparations	Natural flavourings (if necessary) Organic or conventional aroma extracts only for fruit preparations	Aroma extracts of the eponymous fruit or vegetable and etheric oils (organic) Natural flavourings on special permission for fruit preparations only
Processing methods allowed	Pasteurization (as the only heat treatment) Other common methods (except…)	All common methods for the processing of milk (except…)	All common methods for the processing of milk (except…)	All common methods for the processing of milk (except…)	UHT: beta-lactoglobulin >500mg/kg All common methods for the processing of milk (except…)	All common methods for the processing of milk (except…)	All common methods for the processing of milk (except…)
Prohibited processing methods	Sterilization Indirect acidification (nizo method) UHT (ultra-high temperature treatment) ESL (extended shelf life) homogenization (max 30%) Centrifugal whey separation	Sterilization Indirect acidification (nizo method) Production of analogous cheese	Sterilization Indirect acidification (nizo method) Production of analogous cheese	Sterilization Indirect acidification (nizo method)	Sterilization (exception coffee cream) Indirect acidification (nizo method) Production of analogous cheese	Sterilization (exception coffee cream) Indirect acidification (nizo method) UHT (ultra-high temperature treatment)	Sterilization Indirect acidification (nizo method)
Labelling	No specification	Homogenization UHT Ripening in foil Lactose free products	Use of iodized salt 'not homogenized' only up to 15% homogenization level	'Goat cheese' and 'sheep's milk cheese' have to be made from 100% goat/sheep's milk Use of iodized salt	'Goat cheese' and 'sheep's milk cheese' have to be made from 100% goat/sheep's milk Use of iodized salt	'Goat cheese' and 'sheep's milk cheese' have to be made from 100% goat/sheep's milk	No specification

		‘Goat cheese’ and ‘sheep’s milk cheese’ have to be made from 100% goat/sheep’s milk ‘not homogenized’ only up to 15% homogeniza-tion level			‘not homogenized’ only up to 15% homogeniza-tion level		

Source: own table, based on (vgl. Biokreis e.V., 2016)(vgl. Bioland e.V., 2014)(vgl. Biopark e.V., 2016, p. 10)(vgl. Naturland e.V., 2018, pp. 11–12)(vgl. Gäa e.V., 2014, p. 11)(vgl. Naturland e.V., 2018, p. 11)(vgl. Ecoland e.V., 2009, p. 23)(vgl. Demeter-International e.V., 2018, pp. 10–15)(vgl. Bioland e.V., 2017)(vgl. Ecoland e.V., 2009, pp. 21–22)(vgl. Naturland e.V., 2018, pp. 19–20)(vgl. Biokreis e.V., 2019)(vgl. Biopark e.V., 2016, pp. 35–37)(vgl. Gäa e.V., 2014, pp. 46–47)(vgl. Bioland e.V., 2016f)(vgl. Demeter-International e.V., 2018, pp. 44–49)

Table 49 Additives, processing aids, microorganisms, enzymes, and flavourings for the processing of meat and meat products in organic guidelines of German associations

Category	Demeter	Bioland	Naturland	Biokreis	Biopark	Gäa	Ecoland
Additives	Locust bean gum Guar gum Lactic acid Sodium citrate Smoke (from untreated wood)	Lactic acid / sodium lactate Sodium citrate CO_2, N_2, O_2 Smoke (from untreated wood)	Lactic acid Sodium citrate Sodium nitrite Potassium nitrate Sodium sorbate Ascorbic acid Extract of rosemary (organic) Smoke (from untreated wood)	Lactic acid / sodium lactate Sodium citrate Sodium nitrite (with limitations) Potassium nitrate (with limitations) Ascorbic acid CO_2, N_2, O_2 Smoke (from untreated wood)	Potassium / calcium / sodium lactate Potassium / calcium / sodium citrate Sodium nitrite (with limitations) Potassium nitrate (with limitations) Ascorbic acid	Sodium lactate Sodium citrate Sodium nitrite (with limitations) Potassium nitrate (with limitations) Ascorbic acid CO_2, N_2, O_2 Smoke (from untreated wood)	Lactic acid Potassium / calcium / sodium citrate Sodium nitrite (with limitations) Potassium nitrate (with limitations) CO_2, N_2
Processing aids	Native and pregelatinized starch (organic) CO_2, N_2 Plant oils Beeswax Carnauba wax Filter material (asbestos- and chlorine-free) cellulose textiles Diatomite Bentonite Perlite Activated carbon filter CO_2, N_2, O_2, Ar [x]	CO_2, N_2 Plant oils Beeswax	CO_2, N_2	CO_2, N_2 Plant oils Beeswax Beef tallow	CO_2, N_2	CO_2, N_2	CO_2, N_2
	[x] as inert gas/processing aid for all product groups						
	Note: processing aids marked in grey are generally allowed for Demeter food production but not specifically named within this product specific part of the guideline						

Enzymes	Not allowed						
Microorganisms	Common starter cultures (organic) mould	Common starter cultures (organic)	Common starter cultures (organic)	Common starter cultures (organic)	Common starter cultures (organic)	Common starter cultures (organic)	No specification
Flavourings	Organic spice and aroma extracts Yeast products	Organic spice and aroma extracts, etheric oils	Organic spice and aroma extracts (only with permission)	Not allowed (only fluid smoke without additives)	Not allowed	Not allowed	Aroma extracts of the eponymous fruit or vegetable and etheric oils (organic)
Processing methods allowed	Maturation at low temperature (15°C) or medium temperature (18-20°C) Cold, warm and hot smoking Cooling and freezing Hitting blood with metal rods Dry curing and brine bath curing Warm shredding, warm salting (if direct processing is impossible) Full preservation allowed (sterilization, pasteurization) but less is preferred if possible	Common processing procedures for meat products (except…)	Common processing procedures for meat products (except…)	Common processing procedures for meat products (except…)	Common processing procedures for meat products (except…)	Common processing procedures for meat products (except…)	Common processing procedures for meat products (except…)
Prohibited processing methods	Maturation over 20°C Fast maturation methods (e.g. gdl-method) Black smoking Use of tenderizing materials or electric tenderizing Spraying with brine solution or food-grade acid Use of citrates to prevent blood clotting Use of milk protein and other cutting aids	Black smoking Production of pressed meat and mechanically separated meat (high)pressure treatment with oxygen	Black smoking Production of pressed meat and mechanically separated meat (high)pressure treatment with oxygen	Black smoking Production of pressed meat and mechanically separated meat (high)pressure treatment with oxygen	Black smoking Production of pressed meat and mechanically separated meat	Black smoking Production of pressed meat and mechanically separated meat (high)pressure treatment with oxygen Treatment with ionized irradiation	Black smoking Production of pressed meat and mechanically separated meat
Labelling	No specification	No specification	Use of sodium nitrite Use of iodized salt, alcohol, gelatine	Use of sodium nitrite Use of iodized salt, alcohol, gelatine	Use of sodium nitrite Use of iodized salt, alcohol, gelatine	Use of sodium nitrite Use of red wine	

Source: own table, based on (vgl. Biokreis e.V., 2016)(vgl. Bioland e.V., 2014)(vgl. Biopark e.V., 2016, p. 10)(vgl. Naturland e.V., 2018, pp. 11–12)(vgl. Gäa e.V., 2014, p. 11)(vgl. Naturland e.V., 2018, p. 11)(vgl. Ecoland e.V., 2009, p. 23)(vgl. Demeter-International e.V., 2018, pp. 10–15)(vgl. Bioland e.V., 2017)(vgl. Ecoland e.V., 2009, pp. 21–22)(vgl. Biokreis e.V., 2015b)(vgl. Bioland e.V., 2016c)(vgl. Biopark e.V., 2016, pp. 22–27)(vgl. Naturland e.V., 2018, pp. 17–18)(vgl. Gäa e.V., 2014, pp. 32–36)(vgl. Demeter-International e.V., 2018, pp. 39–44)

Table 50 Additives, processing aids, microorganisms, enzymes, and flavourings for the processing of fruits and vegetables in organic guidelines of German associations

Category	Demeter	Bioland	Naturland	Biokreis	Biopark	Gäa	Ecoland
Additives	Locust bean gum Guar gum Agar Pectin, non-amidated	Locust bean gum Guar gum Agar Pectin, non-amidated Ascorbic acid* Citric acid** Calcium citrate*** CO_2, N_2, O_2	Locust bean gum Guar gum Agar Pectin, non-amidated Ascorbic acid* Citric acid* Calcium citrate* Lactic acid Extract of rosemary (organic) Smoke (from untreated wood)	Locust bean gum Agar Pectin, non-amidated Ascorbic acid** Citric acid**** Calcium citrate**** Lactic acid (for olives) Extract of rosemary Smoke (from untreated wood)	Locust bean gum Agar Pectin, non-amidated Ascorbic acid** Citric acid**** Calcium citrate**** Lactic acid (for olives)	Locust bean gum Agar Pectin, non-amidated Ascorbic acid** Citric acid**** Calcium citrate**** Lactic acid (for olives)	Locust bean gum Guar gum Agar Pectin, non-amidated Ascorbic acid Citric acid*** CO_2, N_2
	* only with special permission ** only for potato products (and horseradish and white grape juice [Biopark, Biokreis]) *** only for jelly, jam and fruit spreads and preparations **** only for jelly, jam and fruit spreads and preparations, potato products, horseradish and white grape juice (special permission for other products)						
Processing aids	Native and pregelatinized starch (organic) Gelatine Ethylene* Plant proteins CO_2, N_2 O_2, Ar [X] Plant oils Filter material (asbestos- and chlorine-free) cellulose textiles Diatomite Bentonite Perlite Activated carbon filter	Native and pregelatinized starch (organic) Gelatine Ethylene* CO_2, N_2 Plant oils Beeswax Carnauba wax Filter material (asbestos- and chlorine-free) cellulose textiles Diatomite Bentonite Perlite	Gelatine Ethylene* CO_2, N_2 Beeswax Carnauba wax Filter material (asbestos- and chlorine-free) cellulose textiles Diatomite Bentonite Perlite	Native and pregelatinized starch (organic) Gelatine CO_2, N_2 Plant oils Filter material (asbestos- and chlorine-free) cellulose textiles Diatomite Bentonite	Gelatine CO_2, N_2 Plant oils Filter material (asbestos- and chlorine-free) cellulose textiles Diatomite Bentonite Perlite	Gelatine (organic) Ethylene* CO_2, N_2 Plant oils Filter material (asbestos- and chlorine-free) cellulose textiles Diatomite Bentonite	Gelatine CO_2, N_2 Filter material (asbestos- and chlorine-free) Diatomite Bentonite Perlite

	Potash Silica sol		Potash Magnesium chloride Calcium sulphate				
	* only for ripening of bananas [X] as inert gas/processing aid for all product groups						
Enzymes	Not allowed	Not allowed	Not allowed	Amylolytic, pectolytic, proteolytic enzymes only if necessary and inactivated by heat afterwards	Amylolytic, pectolytic, proteolytic enzymes only if necessary and inactivated by heat afterwards		No specification
Microorganisms	Common starter cultures (organic)	Common starter cultures (organic)	Common starter cultures (organic)	Common starter cultures Yeast extract (organic)	Common starter cultures yeast extract (organic)	Common starter cultures (organic)	No specification
Flavourings	None, if possible Otherwise organic aroma extracts	None, if possible Otherwise organic aroma extracts, natural flavours, etheric oils	Aroma extracts and natural flavours only with permission	Not allowed	Natural flavourings (if necessary) Organic or conventional aroma extracts only for fruit preparations	(if available organic) Aroma extracts and etheric oils only for fruit preparations	Aroma extracts of the eponymous fruit or vegetable and etheric oils (organic) Natural flavourings on special permission for fruit preparations only
Processing methods allowed	Mechanical chopping Homogenization Drying Sterilization (HTST) Pasteurization Cooling Carbonic acid pressure treatment (juice) Aseptic bottling Cloudy juices preferred Clarification (with permission only)	Common processing procedures for fruits and vegetables (except…)	Common processing procedures for fruits and vegetables (except…)	Common processing procedures for fruits and vegetables (except…)	Common processing procedures for fruits and vegetables (except…)	Common processing procedures for fruits and vegetables (except…)	
Prohibited processing methods	Reconstitution of concentrate Use of ion exchangers and adsorber resin Vegetable processing: Freeze-drying High frequency drying	Reconstitution of concentrate Use of ion exchangers and adsorber resin	Reconstitution of concentrate Use of ion exchangers and adsorber resin	Reconstitution of concentrate Use of ion exchangers and adsorber resin	Reconstitution of concentrate	Reconstitution of concentrate	

	Chemical dehumidification (salts, fossil fuels) preservation with sulphur dioxide or sulphate solution						
Labelling	No specification	No specification	Use of iodized salt	Use of iodized salt	Use of iodized salt	Especially ingredients and additives with known allergy potential	

Source: own table, based on (vgl. Biokreis e.V., 2016)(vgl. Bioland e.V., 2014)(vgl. Biopark e.V., 2016, p. 10)(vgl. Naturland e.V., 2018, pp. 11–12)(vgl. Gäa e.V., 2014, p. 11)(vgl. Naturland e.V., 2018, p. 11)(vgl. Ecoland e.V., 2009, p. 23)(vgl. Demeter-International e.V., 2018, pp. 10–15)(vgl. Bioland e.V., 2017)(vgl. Ecoland e.V., 2009, pp. 21–22)(vgl. Demeter-International e.V., 2018, pp. 20–27)(vgl. Biokreis e.V., 2015e)(vgl. Bioland e.V., 2016d)(vgl. Naturland e.V., 2018, pp. 31–32)(vgl. Gäa e.V., 2014, pp. 37–38)(vgl. Biopark e.V., 2016, pp. 27–29)

Table 51 Additives, processing aids, microorganisms, enzymes, and flavourings for the processing of bread and baked goods in organic guidelines of German associations

Category	Demeter	Bioland	Naturland	Biokreis	Biopark	Gäa	Ecoland
Additives	Locust bean gum Guar gum Agar Pectin, non-amidated Gelatine (organic)*** Tartaric acid baking powder Potassium carbonates* (potash) Sodium hydroxide** Acerola powder**** Gluten Fermentation alcohol	Locust bean gum Guar gum Pectin, non-amidated Gelatine (organic) Tartaric acid baking powder Potassium carbonates (potash) Sodium hydroxide** Gluten Fermentation alcohol Lecithin (native, not modified, organic) Ammonium bicarbonate (Hirschhornsalz) CO_2, N_2, O_2	Locust bean gum Guar gum Pectin, non-amidated Gelatine (organic) Tartaric acid baking powder Potassium carbonates (potash) Sodium hydroxide** Gluten Fermentation alcohol Lecithin (native, not modified, organic) Ammonium bicarbonate (Hirschhornsalz)	Locust bean gum***** Guar gum***** Agar Pectin, non-amidated Gelatine (organic) Tartaric acid baking powder Potassium carbonates (potash) Sodium hydroxide** Lecithin (native, not modified, organic) Ammonium bicarbonate (Hirschhornsalz) Native and pregelatinized starch (organic)	Locust bean gum Guar gum Agar Pectin, non-amidated Gelatine (organic)** Tartaric acid baking powder Potassium carbonates (potash) Lecithin (native, not modified, organic) Ammonium bicarbonate (Hirschhornsalz) CO_2, N_2	Locust bean gum***** Guar gum***** Agar Pectin, non-amidated Tartaric acid baking powder Potassium carbonates (potash) Sodium hydroxide** Lecithin (native, not modified, organic) Ammonium bicarbonate (Hirschhornsalz)	Locust bean gum Guar gum Agar Pectin, non-amidated Tartaric acid baking powder Potassium carbonates (potash) Sodium hydroxide** Lecithin (organic) Ammonium bicarbonate (Hirschhornsalz)
	* for ginger and honey bread only ** for lye bakery production *** only for baking products containing yoghurt, cottage cheese or cream **** only for small bakery items, baguette, rusks, and toast ***** only for gluten free products						
Processing aids	Native and pregelatinized starch (organic) Grain, malt or soy flours Plant oils Beeswax Carnauba wax Filter material (asbestos- and chlorine-free) cellulose	Native starch Grain flours Plant oils Lecithin (native, not modified, organic) Beeswax Carnauba wax	Native starch Plant oils Beeswax Carnauba wax	Native and pregelatinized starch (organic) Grain flours Plant oils Lecithin Beeswax Carnauba wax Butter	Grain flours Plant oils Lecithin Beeswax Carnauba wax Butter	Grain flours (organic) Plant oils Lecithin (organic) Beeswax Carnauba wax Butter, margarine (organic)	Plant oils (organic) Lecithin (organic) Beeswax Carnauba wax

	textiles Diatomite Bentonite Perlite Activated carbon filter CO_2, N_2, O_2, Ar [X]						
	[X] as inert gas/processing aid for all product groups						
	Note: processing aids marked in grey are generally allowed for Demeter food production but not specifically named within this product specific part of the guideline						
Enzymes	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	No specification
Microorganisms	Baking ferment Sour dough (produced in own bakery) Yeast	Baking ferment Sour dough (produced in own bakery) Yeast	Baking ferment Sour dough (produced in own bakery) Yeast	Baking ferment (based on grains, legume flour and honey) Sour dough (preferably produced in own bakery)	Baking ferment (based on grains, legume flour and honey) Sour dough (preferably produced in own bakery) Dry sour dough Yeast (no GMO, organic)	Baking ferment (based on grains, legume flour and honey) Sour dough (organic) Yeast	No specification
Flavourings	pure etheric oils or pure extracts identical with the parent material (physically extracted) only in pastries	pure etheric oils or pure extracts (organic)	Not allowed	pure etheric oils or pure extracts identical with the parent material	pure etheric oils or pure extracts (organic) only in pastries	pure etheric oils or pure extracts (organic if available) only in pastries	Aroma extracts of the eponymous fruit or vegetable and etheric oils (organic)
Processing methods allowed	Milling (preferably stone mills) Gas ovens preferred	Common processing procedures for bread and baked goods	Common processing procedures for bread and baked goods	Common processing procedures for bread and baked goods Preferably use of flour with a high extraction level (high mineral content)	Common processing procedures for bread and baked goods	Common processing procedures for bread and baked goods Preferably use of flour with a high extraction level (high mineral content)	
Prohibited processing methods	Use of baking foil (except for small baking items as pretzels, buns) Use of hammer mills without internal cooling Freezing baked through goods and selling them as defrosted products High frequency infra-red ovens						

	Single use baking forms made of aluminium						
Labelling	No specification	“whole wheat bread” labelling only if 100% whole wheat flour	“whole wheat bread” labelling only if 100% whole wheat flour	Use of iodized salt, gelatine, flour type “whole wheat bread” labelling only if 100% whole wheat flour Egg free, whole egg, yolk or egg white	Use of iodized salt, gelatine, flour type “whole wheat bread” labelling only if 100% whole wheat flour	Declaration of flour type that has been used “whole wheat bread” labelling only if 100% whole wheat flour	

Source: own table, based on (vgl. Biokreis e.V., 2016)(vgl. Bioland e.V., 2014)(vgl. Biopark e.V., 2016, p. 10)(vgl. Naturland e.V., 2018, pp. 11–12)(vgl. Gäa e.V., 2014, p. 11)(vgl. Naturland e.V., 2018, p. 11)(vgl. Ecoland e.V., 2009, p. 23)(vgl. Demeter-International e.V., 2018, pp. 10–15)(vgl. Bioland e.V., 2017)(vgl. Ecoland e.V., 2009, pp. 21–22)(vgl. Demeter-International e.V., 2018, pp. 29–32)(vgl. Biokreis e.V., 2015d)(vgl. Bioland e.V., 2016a)(vgl. Biopark e.V., 2016, pp. 18–20)(vgl. Naturland e.V., 2018, pp. 21–22)(vgl. Gäa e.V., 2014, pp. 26–27)

Table 52 Additives, processing aids, microorganisms, enzymes, and flavourings for the processing of pasta, grain, and cereal products in organic guidelines of German associations

Category	Demeter	Bioland	Naturland	Biokreis	Biopark	Gäa	Ecoland
Additives	Locust bean gum Guar gum Agar Tartaric acid baking powder	Tartaric acid baking powder Lecithin (native, not modified, organic) CO_2, N_2, O_2 (not for pasta)	Not allowed	Not allowed	Not allowed	Not allowed	*For grain products only:* Tartaric acid baking powder Lecithin (organic) CO_2, N_2
Processing aids	*Starch production:* Sodium hydroxide* CO_2, N_2 Native and pregelatinized starch (organic) Plant oils Beeswax Carnauba wax Filter material (asbestos- and chlorine-free) cellulose textiles Diatomite Bentonite Perlite Activated carbon filter CO_2, N_2, O_2, Ar [X]	*Grain & cereal products:* CO_2, N_2, O_2 *For pasta production processing aids are not allowed*	Sodium carbonate* CO_2, N_2	CO_2, N_2	CO_2, N_2	CO_2, N_2	*Starch production:* Sodium hydroxide* Sodium carbonate* CO_2, N_2
	[X] as inert gas/processing aid for all product groups						
	* to adjust pH in starch production						
	Note: processing aids marked in grey are generally allowed for Demeter food production but not specifically named within this product specific part of the guideline						
Enzymes	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	No specification

Microorganisms	*Only for baking mixes:* Baking ferment Sour dough (produced in own bakery) Dried sour dough granules Organic yeast	Sour dough (produced in own bakery) Dried sour dough granules Organic yeast Lactic acid bacteria *Not allowed for pasta production*	Common cultures (organic)	Common cultures (organic, if available)	Common cultures (organic, if available)	Common starter cultures (organic, if available)	No specification
Flavourings	pure etheric oils or pure extracts identical with the parent material (physically extracted)	*Only for grain and cereal products:* pure etheric oils or pure extracts (organic)	Not allowed	Organic aroma extracts, e.g. etheric oils	Natural flavourings (if necessary)	Organic aroma extracts	Aroma extracts of the eponymous fruit or vegetable and etheric oils (organic)
Processing methods allowed	Processing of parboiled rice from DEMETER rice Shaping extrusion (max 75°C, 90 bar)	Common processing procedures for pasta, grain and cereal products	Common processing procedures for pasta, grain and cereal products	Common processing procedures for pasta, grain and cereal products (except…)	Common processing procedures for pasta, grain and cereal products (except…)	Common processing procedures for pasta, grain and cereal products (except…)	Common processing procedures for pasta, grain and cereal products (except…)
Prohibited processing methods	Production of modified starch Modifying extrusion			Production of chemically or enzymatically modified starch	Production of chemically or enzymatically modified starch	Production of chemically or enzymatically modified starch	Production of chemically or enzymatically modified starch (exception: starch saccharification products) *Pasta:* Measures to reduce cooking time (e.g. instant pasta) Infrared drying Sterilization of filled pasta
Labelling	No specification	No specification	No specification	Use of iodized salt Egg free, whole egg, yolk or egg white “whole wheat” labelling only if 100% whole wheat flour	Use of iodized salt Egg free, whole egg, yolk or egg white	Egg free, whole egg, yolk or egg white	No specification

Source: own table, based on (vgl. Biokreis e.V., 2016)(vgl. Bioland e.V., 2014)(vgl. Biopark e.V., 2016, p. 10)(vgl. Naturland e.V., 2018, pp. 11–12)(vgl. Gäa e.V., 2014, p. 11)(vgl. Naturland e.V., 2018, p. 11)(vgl. Ecoland e.V., 2009, p. 23)(vgl. Demeter-International e.V., 2018, pp. 10–15)(vgl. Bioland e.V., 2017)(vgl. Ecoland e.V., 2009, pp. 21–22)(vgl. Biokreis e.V., 2015c)(vgl. Bioland e.V., 2016e)(vgl. Naturland e.V., 2018, pp. 23–24)(vgl. Gäa e.V., 2014, pp. 39–40)(vgl. Biopark e.V., 2016, pp. 29–33)(vgl. Bioland e.V., 2016h)(vgl. Demeter-International e.V., 2018, pp. 33–35)

Table 53 Additives, processing aids, microorganisms, enzymes, and flavourings for the processing of soy products in organic guidelines of German associations

Category	Demeter	Bioland	Naturland	Biokreis	Biopark	Gäa	Ecoland
Additives	Locust bean gum Guar gum Sodium bicarbonate* Native and pregelatinized starch (organic) Smoke (from untreated wood)	Locust bean gum Guar gum Agar Native and pregelatinized starch (organic) Pectin, non-amidated CO_2, N_2, O_2 Smoke (from untreated wood)	*Naturland does not provide any regulations concerning soy products*	*Biokreis does not provide any regulations concerning soy products*	Locust bean gum Guar gum Agar Pectin, non-amidated CO_2, N_2 Smoke (from untreated wood)	Locust bean gum Guar gum Agar Pectin, non-amidated CO_2, N_2 Smoke (from untreated wood)	Locust bean gum Guar gum Agar Pectin, non-amidated CO_2, N_2
	* Only for tofu						
Processing aids	CO_2, N_2 Calcium sulphate* Magnesium chloride* Sodium bicarbonate Beeswax Carnauba wax Filter material (asbestos- and chlorine-free) cellulose textiles Diatomite Bentonite Perlite Activated carbon filter CO_2, N_2, O_2, Ar [X]	CO_2, N_2 Calcium sulphate* Magnesium chloride* Calcium carbonate			CO_2, N_2 Calcium sulphate* Magnesium sulphate* Calcium chloride* Magnesium chloride* Calcium carbonate	CO_2, N_2 Calcium sulphate* Magnesium chloride* Calcium carbonate	CO_2, N_2 Calcium sulphate Calcium chloride Magnesium chloride Calcium carbonate
	[X] as inert gas/processing aid for all product groups * for coagulation in tofu production						
	Note: processing aids marked in grey are generally allowed for Demeter food production but not specifically named within this product specific part of the guideline						
Enzymes	Not allowed	Not allowed			Not allowed	Not allowed	No specification

Microorganisms	Common starter cultures	Mould cultures: - Rhizopus oligoporus for Tempeh - Koji for soy sauce - Aspergillus oryzae for Miso Common starter cultures for soy sauce production			Mould cultures: - Rhizopus oligoporus for Tempeh - Koji for soy sauce - Aspergillus oryzae for Miso Common starter cultures for soy sauce production	Mould cultures: - Rhizopus oligoporus for Tempeh - Koji for soy sauce - Aspergillus oryzae for Miso Common starter cultures for soy sauce production	No specification
Flavourings	pure etheric oils or pure extracts identical with the parent material (physically extracted)	*Only for grain and cereal products:* pure etheric oils or pure extracts (organic)			Natural flavourings (if necessary), organic or conventional aroma extracts only for fruit preparations	Organic aroma extracts	Aroma extracts of the eponymous fruit or vegetable and etheric oils (organic)
Processing methods allowed	Smoking with hardwoods (as wood, shavings or sawdust) UHT for soy drink production (max 135-155°C)	Common processing procedures for soy products			Common processing procedures for soy products	Common processing procedures for soy products	
Prohibited processing methods	Smoking with tropical hardwoods or ‘liquid’ smoke Extrusion technology						
Labelling	No specification	No specification			No specification	No specification	

Source: own table, based on (vgl. Biokreis e.V., 2016)(vgl. Bioland e.V., 2014)(vgl. Biopark e.V., 2016, p. 10)(vgl. Naturland e.V., 2018, pp. 11–12)(vgl. Gäa e.V., 2014, p. 11)(vgl. Naturland e.V., 2018, p. 11)(vgl. Ecoland e.V., 2009, p. 23)(vgl. Demeter-International e.V., 2018, pp. 10–15)(vgl. Bioland e.V., 2017)(vgl. Ecoland e.V., 2009, pp. 21–22)(vgl. Bioland e.V., 2016b)(vgl. Biopark e.V., 2016, pp. 38–39)(vgl. Gäa e.V., 2014, pp. 49–50)(vgl. Demeter-International e.V., 2018, pp. 33–35)

Table 54 Additives, processing aids, microorganisms, enzymes, and flavourings for the processing of oil and fats in organic guidelines of German associations

Category	Demeter international	Bioland	Naturland	Biokreis	Biopark	Gäa	Ecoland
Additives	Not allowed for oils Lecithin (native, not modified, organic) only for margarine	Not allowed for oils Lecithin (native, not modified, organic) only for margarine	Not allowed	Not allowed	Not allowed	Not allowed	
Processing aids	Citric acid* ** N_2 Native and pregelatinized starch (organic) Filter material (asbestos- and chlorine-free) Cellulose Textiles Diatomite Bentonite** Perlite Activated carbon filter** CO_2, N_2, O_2, Ar [X]		Citric acid N_2 Filter material (asbestos- and chlorine-free) Cellulose Textiles Diatomite Bentonite** Perlite Activated carbon filter**	Citric acid*** N_2 Ethanol (not for native oils) Filter material (asbestos- and chlorine-free) Cellulose Textiles Diatomite Activated carbon filter***	Citric acid*** N_2 Ethanol (not for native oils) Filter material (asbestos- and chlorine-free) Cellulose Textiles Diatomite Activated carbon filter***	Citric acid*** N_2, CO_2, O_2 Ethanol (only for raw materials with low fat content) Filter material (asbestos- and chlorine-free) Cellulose Textiles Diatomite Perlite Activated carbon filter***	CO_2, N_2 Ethanol (only for raw materials with low fat content) Filter material (asbestos- and chlorine-free) Diatomite Perlite
	[X] as inert gas/processing aid for all product groups * only for removal mucilage ** for oil for processing purposes *** only for deodorized palm and coconut oil						
	Note: processing aids marked in grey are generally allowed for Demeter food production but not specifically named within this product specific part of the guideline						
Enzymes	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	No specification
Microorganisms	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	No specification
Flavourings	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed	Aroma extracts of the eponymous fruit or vegetable and etheric oils (organic) generally permitted
Processing methods allowed	*Cold-pressed oils:* Usual methods for cleaning, peeling and	Common methods for processing of oil and fats (except specifically prohibited)	*Plant oils:* Usual methods for cleaning, peeling and preparation of raw materials (conditioning and	*Plant oils:* Usual methods for cleaning, peeling and preparation of raw materials (conditioning and	*Plant oils:* Usual methods for cleaning, peeling and preparation of raw materials (conditioning and	*Plant oils:* Usual methods for cleaning, peeling and preparation of raw materials (conditioning and	Extraction (only using water, ethanol, plant oils, acid, CO2, N2 and carboniferous acids; the extraction aids have to fulfil

	preparation of raw materials Mechanical pressing (extraction temperature measurement close to the outlet) Max. extraction temperatures (lower recommended): Olive <27°C Saffron 50°C Pumpkin seed 50°C Sunflower 60°C Maize, soy, sesame, hazelnut 60°C Filtration Decanting Centrifugation Roasting the seeds before pressing (for pumpkin seed, sesame and nut oils) *Other oils (for baking, frying, processing):* Same methods that are allowed for cold oils Additionally: Conditioning and drying of raw material with heat Removal of mucilage Neutralizing/buffering pH Washing Vacuum drying Bleaching/removal of colour Thermal fractionation (decrystallization / dry fractionation) Steaming/Deodorising (once, with max 230°C)	*Plant oils:* Usual methods for cleaning, peeling and preparation of raw materials (conditioning and pre-warming up to outlet temperature) Mechanical pressing Max. extraction temperatures (lower recommended): Olive 40°C Linseed 40°C Pumpkin seed 50°C Thistle 50°C Other oils 60°C Filtration Decanting Centrifugation *Oils for baking, frying, processing:* Bleaching/removal of colour with active charcoal and bentonite Steaming (max 180°C for frying, 240°C for further processing) *Animal products:* Rendering (if possible wet rendering)	pre-warming up to outlet temperature) Mechanical pressing Max. extraction temperatures (lower recommended): Olive 40°C Pumpkin seed 50°C Thistle 50°C Sunflower, maize, soy, sesame, hazelnut and other oils 60°C Filtration Decanting Centrifugation Steaming (with special approval, max. 160°C) Deodorizing (only for sunflower oil for further processing, palm and coconut oil) Removal of mucilage with citric acid (only for deodorized palm, coconut and sunflower oil) *Animal products:*	pre-warming up to outlet temperature) Mechanical pressing (extraction temperature measurement close to the outlet) Max. extraction temperatures (lower recommended): Olive 40°C Pumpkin seed 50°C Thistle 50°C Sunflower, maize, soy, sesame, hazelnut and other oils 60°C Filtration Decanting Centrifugation Steaming (with special approval, max. 160°C) Deodorizing (only for sunflower oil for further processing, palm and coconut oil) Removal of mucilage with citric acid (only for deodorized palm, coconut and sunflower oil) *Animal products:* Rendering	pre-warming up to outlet temperature) Mechanical pressing (extraction temperature measurement close to the outlet) Max. extraction temperatures (lower recommended): Olive 40°C Linseed 40°C Pumpkin seed 50°C Thistle 50°C Sunflower, maize, soy, sesame, hazelnut and other oils 60°C Filtration Decanting Centrifugation Steaming (with special approval, max. 160°C) Deodorizing (only for oils for further processing) Removal of mucilage with citric acid (only for deodorized palm and coconut oil) *Animal products:* Rendering	pre-warming up to outlet temperature) Mechanical pressing Max. extraction temperatures (lower recommended): Olive 40°C Pumpkin seed 50°C Thistle 50°C Sunflower, maize, soy, sesame, hazelnut and other oils 60°C Filtration Decanting Centrifugation Steaming (with special approval, max. 160°C) Deodorizing (only for oils for further processing) Removal of mucilage with citric acid (only for deodorized palm and coconut oil) *Animal products:* Rendering	food quality standards and be suitable for extraction Common methods for processing of oil and fats (except specifically prohibited)

	Animal products: Rendering *Margarine:* Emulsification Pasteurization Crystallization		Rendering				
Prohibited processing methods	*Cold-pressed oils:* Conditioning/pre-warming of raw material Extraction with chemical solvents Mucilage removal with organic acids Use of active charcoal Removal of acid Bleaching/removal of colour Chemical modification *Other oils (for baking, frying, processing):* Extraction with organic solvents Chemical midfication *For palm oil which will be sold as raw palm oil:* Mucilage removal with acids Removal of acid *Margarine:* Use of hardened fats	Extraction with chemical solvents Mucilage removal with organic acids Removal of acid Bleaching/removal of colour Chemical modification Deodorizing *Generally forbidden:* GMO methods Microwaves Ionized radiation Microbiocidal gases	Extraction with chemical solvents Mucilage removal with organic acids (exception palm, coconut, sunflower oil) Removal of acid Bleaching/removal of colour Chemical modification Deodorizing	Extraction with chemical solvents Mucilage removal with organic acids (exception deodorized palm and coconut oil) Removal of acid Bleaching/removal of colour Chemical modification Deodorizing (exception sunflower, palm and coconut oil for further processing)	Extraction with chemical solvents Mucilage removal with organic acids (exception palm and coconut oil) Removal of acid Bleaching/removal of colour Chemical modification Deodorizing (exception sunflower, palm and coconut oil for further processing)	Extraction with chemical solvents Mucilage removal with organic acids (exception deodorized palm and coconut oil) Removal of acid Bleaching/removal of colour Chemical modification Deodorizing (exception oils for further processing)	Extraction with chemical solvents Mucilage removal with organic acids Removal of acid Bleaching/removal of colour Chemical modification Deodorizing above 160°C (exception oils for further processing)
Labelling	Roasted seeds before pressing Deodorising (steaming) Use of lecithin in margarine production For further labelling	Steaming / Deodorizing 'native' or 'cold pressed' declaration only for oils that have not undergone	'native' or 'cold pressed' declaration only for oils that have not undergone any processing steps (incl steaming, extraction with ethanol)	'native' or 'cold pressed' declaration only for oils that have not undergone any processing steps (incl steaming, extraction with ethanol)	'native' or 'cold pressed' declaration only for oils that have not undergone any processing steps (incl steaming, extraction with ethanol)	Steaming 'native' or 'cold pressed' declaration only for oils that have not undergone any processing steps	'native' or 'cold pressed' declaration only for oils that have not undergone any processing steps (incl steaming, extraction with ethanol)

	‘please consult national food regulations’	any processing steps (including steaming)				(including steaming, extraction with ethanol)	

Source: own table, based on (vgl. Biokreis e.V., 2016)(vgl. Bioland e.V., 2014)(vgl. Biopark e.V., 2016, p. 10)(vgl. Naturland e.V., 2018, pp. 11–12)(vgl. Gäa e.V., 2014, p. 11)(vgl. Naturland e.V., 2018, p. 11)(vgl. Ecoland e.V., 2009, p. 23)(vgl. Demeter-International e.V., 2018, pp. 10–15)(vgl. Bioland e.V., 2017)(vgl. Ecoland e.V., 2009, pp. 21–22)(vgl. Biokreis e.V., 2015a)(vgl. Gäa e.V., 2014, pp. 30–31)(vgl. Biopark e.V., 2016, pp. 20–22)(vgl. Demeter-International e.V., 2018, pp. 52–54)(vgl. Bioland e.V., 2016g)(vgl. Naturland e.V., 2018, pp. 35–36)

Table 55 BioSuisse processing regulations for specific milk products

Product / Methods	Permitted	Prohibited	Labelling
Drinking milk	- Centrifugation - (double)bactufugation - Thermal treatment (phosphatase positive) - Pasteurization (once) - Microfiltration (after microfiltration and pasteurization: ß-lactoglobulin min. 3100mg/l, no double heat treatment, max temperature for cream 90°C - UHT-treatment (afterwards ß-lactoglobulin >500mg/l - Homogenization - Fat standardization (e.g. low-fat milk) - Deep cooling of sheep's, goat, mare, buffalo milk (only allowed for these animal's milk because their lactation period is shorter and fresh milk might not be available all year long)	- Fat standardization for whole milk (After fat standardization it may not be called "whole" milk anymore. Standardization in general to achieve a certain fat content is allowed if labelled correctly) - Multiple pasteurization - High-temperature pasteurization - Sterilization - Freezing of cow's milk (because it is available as fresh milk in Switzerland all year long)	- Bactofugation, thermal treatment, pasteurization, UHT, homogenization, microfiltration - Front of package if double bactofugation/ microfiltration: "pasteurized" or "double bactofugated"/ "microfiltrated" - Fat standardization with fat content - Standardized 3,5% milk may not be called "standardized whole milk" (only "standardized milk", as to Bio Suisse after the standardization process the milk does not have its "whole" fat content anymore) - "fresh" or similar denotation only for classic pasteurized milk (not after double bactofugation or microfiltration) - Deep cooling of sheep's, goat, mare, buffalo milk (no specification why for these but not for cow's milk)
Yoghurt and other fermented milk products	- Fat standardization - (high temperature) pasteurization - Evaporation to raise dry mass - Homogenization of milk: 200 bar, max 250 bar - Fermentation with lactic acid bacteria	- Reheating after lactic acid fermentation	- Pasteurization (also evaporation) - Homogenization
Dry milk (products)	- (double) bactufugation - (high temperature) pasteurization - Microfiltration - Ultrafiltration - Fat and protein standardization - Thickening in vacuo - Spray drying and drum drying (semi instantization) - Freeze-drying (case-by-case) - Protein isolation (without heat, acid or alkali) - Acid precipitation of casein	- Protein isolation with heat, acid or alkali - Use of anti-caking agents	- Standardization of protein content
Buttermilk, whey, milk drinks	No specification	- Use of lactic acid and other acidifiers (only lactic acid bacteria)	
Cream (products)	- Pasteurization (once for cream) - High-temperature pasteurization: above 90°C only in justified cases ("justified case" not specified) - Direct and indirect UHT for coffee cream - Fermentation with lactic acid bacteria	- UHT whipping cream - Use of thickeners	- Pasteurization - UHT treatment

Cheese	Cheese milk and ripened cheese	- (double) bactufugation; UHT bactofugate may be used in processing - Thermal treatment (phosphatase positive) - Pasteurization (once) - Fat standardization (e.g. low-fat milk) - Storage in foil and foil ripening only in special approved cases (e.g. melting cheese) - Sterilization of brine bath: only physical methods - Smoking/Fumigation	- Use of chemical colours, synthetical components as glue or coating agents	- Thermal treatment and pasteurization of milk used for cheese production
	Cream cheese and curd	- Same methods that are allowed for ripened cheese Additional: - Homogenization of milk - High-temperature pasteurization of milk - Centrifugation of jelly	- Addition of water - Standardization of dry mass of curd with water - Use of chemical colours, synthetical components as glue or coating agents	- Homogenization - Thermal treatment and pasteurization of milk used for cheese production
Whey cheese and mascarpone		- Acid heat precipitation	No specification	No specification
Cheese Products		- Only use of cheese processed according to Bio Suisse guidelines - Mixing - Melting with heat and emulsion process - Heating methods	No specification	No specification
Butter(preparations) and milk fat fractions		- Processing methods for cream - Thermal treatment (phosphatase positive) - (High)Pasteurization - Acidifying cultures for microbial cream ripening - Addition of salt (salted butter) - Addition of microbially produced lactic acid concentrate (not for “premium butter”) - Freezing of butter to meet production and demand variation for max. 14 months - Melting, centrifugation, deodorization for certain products (butter fat, frying butter, etc.) - fractional crystallisation (thermal fractionation) for producing butter fractions	- Addition of microbially produced lactic acid concentrate for “premium butter” - Sale of frozen butter as “premium butter” - Addition of flavour distillate - Preservation with antioxidants	- Form of heat treatment (thermal treatment, pasteurization) of cream - Thermal effect during centrifugation - Butter production of unpasteurized cream - Use of frozen butter - If labelled as cultured butter it has to be made out of sour cream (no addition of lactic acid concentrate)
Desserts (e.g. Panna Cotta, rice pudding)		- (double) bactufugation - Thermal treatment (phosphatase positive) - (High)Pasteurization - Fat standardization - Homogenization: 200 bar, max 250 bar	- Sterilization	- (double) bactufugation - Thermal treatment (phosphatase positive) - (High)Pasteurization - Homogenization
Ice cream and sherbet		- Mixing	No specification	- Pasteurization

	- Homogenization: 200 bar, max 250 bar - (High)Pasteurization - Double pasteurization of milk and cream - Deep-freezing		- Homogenization

Source: own table based on (vgl. Bio Suisse, 2019, pp. 183–191)

Table 56 Bio Suisse processing regulations for meat products

Permitted	Prohibited	Labelling
Curing with nitrite (permitted, but desirable without) Alternative reddening process with nitrate-containing vegetable powder Cooking, boiling Drying Smoking Pasteurization Sterilization (meat cans) Deep cooling Cooling temperature above -2°C	High-pressure process Use of flavour enhancers, hydrolysed proteins, enzymes, flavourings, synthetic ascorbic acid, phosphates, glucono-delta-lactone	Use of nitrate-containing vegetable powder Defrosted meat

Source: own table based on (vgl. Bio Suisse, 2019, pp. 192–194)

The general goal for Bio Suisse meat processing is to process without nitrite or nitrate. However, the use of those substances is not generally prohibited with the argument that producers and consumers can choose which products they want to produce / buy. Enzymes or flavourings may not be used in meat processing.

Permitted processing aids and additives:

- Lactic acid
- Sodium citrate
- Sodium nitrite
- Potassium nitrate (saltpetre)
- Untreated wood and wood chips for smoking
- O_2, CO_2, N_2

Table 57 Bio Suisse processing regulations for insect products

Permitted	Prohibited	Labelling
- Grinding, shredding - Mixing - Heating up, cooking - Drying - Pressing - Baking, roasting, frying, grilling, toasting - Pasteurization - Cooling - Deep-freezing	No specification	- Pasteurization

Source: own table based on (vgl. Bio Suisse, 2019, p. 195)

Table 58 Bio Suisse processing regulations for fruits, vegetables herbs, fungi, sprouts

Permitted	Prohibited	Labelling
- Direct juices - Washing with drinking water only, addition of citric acid, lemon juice, organic acid or organic extract of rosemary (if containing chloride – periodical controls)	- Re-diluted concentrates - Addition of synthetic ascorbic acid to washing water	

Source: own table based on (vgl. Bio Suisse, 2019, pp. 196–203)

Table 59 Bio Suisse processing regulations for specific products from fruits, vegetables, herbs, fungi, sprouts

	Permitted	Prohibited	Labelling
Fruit and vegetable products (including cans)	- Fermentation - Deep cooling - Pasteurization - Sterilization - In oil - Blanching - Mechanical peeling and preparing, steam peeling - Concentrating - Drying - Flaking - Roasting (e.g. onions)	- Brine peeling - Reconstruction of concentrates/dry products (e.g. potato puree from potato flakes and liquid = unnecessary processing step) (The production of potato flakes for reconstitution by the consumer is allowed. Only the reconstitution during the actual processing procedure is not permitted because it strikes with the BioSuisse principle of as little processing as possible)	- Pasteurization - Sterilization - Blanching and deep cooling in list of ingredients
Fruit and vegetable juices, nectars and syrups	- Mechanical extraction of juice - (ultra)filtration - Clarifying - Fining - Pasteurisation - Sterilization - Centrifugation - Fermentation - Peeling - Deep cooling	- Brine peeling - Re-dilution of concentrate (exception: more than 25% water diluted drinks)	- Sugar addition - Pasteurisation - Sterilization - Deep cooling
Jam and jelly	- Preserving (boiling down)	No specification	No specification
Fruit bases for yoghurt, milk products, ice cream and sherbet	- Mixing - Deep cooling - Pasteurization: max 105°C for 10 min (exception nuts and fruits that cannot be imported fresh or cooled)	- Use of sterile fruit pulps (Sterilization of fruit pulps is considered an unnecessary processing step) - Colouring with fruit concentrate of a fruit that is not part of the product name	No specification
Fungi	- Same as for fruit and vegetable processing	- Same as for fruit and vegetable processing	No specification
Rungs and forcing	- Water used during processing has to be drinking water without chlorine - Disinfection of seeds with hot water or soap solution before germination - Same as for fruit and vegetable processing	- Same as for fruit and vegetable processing	No specification
Herbs	- Same as for fruit and vegetable processing	- Same as for fruit and vegetable processing	No specification

Cold drinks (from tea, herbs, fruits, vegetables) – iced tea and lemonade	- Use of etheric oils, extracts and distillates from "Knospe"-raw materials (organic carrier materials) - Use of fruit and vegetable juices - Colouring juices only of eponymous fruits/vegetables, caramel and malt Common processing methods	- Use of usual organic flavourings - Use of fruit and vegetable powder - Synthetic sweeteners	No specification

Source: own table based on (vgl. Bio Suisse, 2019, pp. 196–203)

Permitted additives and processing aids:

- Extract of rosemary
- Lemon juice or concentrate, acid
- Arabic gum (coating)
- N2, O2, CO2
- Anti-caking agents: calcium and magnesium carbonate
- Lactic acid (if acidification is not possible with lemon juice or concentrate)
- Citric acid (if acidification is not possible with lemon juice or concentrate)
- Acidifying cultures
- Ethylene (for ripening of bananas)
- Pectin, non-amidated
- Tartaric acid
- Agar

Prohibited:

- Stabilisers
- Colouring additives

- Filtration materials:
  - cellulose, textiles, membranes (asbestos- and chlorine-free)
  - Diatomite
  - Bentonite
  - Activated carbon
  - Perlite
  - Silicon dioxide (gel or colloidal solution)
- Clarifying and fining agents:
  - Microbial pectinases, amylases, hemicellulases
  - Albumin (egg-white)
  - Casein
  - Gelatine (organic)

Table 60 Bio Suisse processing regulations for grains, legumes, and plant protein

Permitted	Prohibited	Labelling
- Pasta products from fresh or frozen vegetables	- Vegetable pasta products from vegetable powder - Use of synthetic ascorbic acid for baked goods	

Source: own table based on (vgl. Bio Suisse, 2019, pp. 204–209)

Table 61 Bio Suisse processing regulations for specific products from grains, legumes, and plant protein

	Permitted	Prohib-ited	Labelling
Grains, legumes, milling products, grains mixes, muesli/cereals	- Common mechanical cleaning methods - Drying - Common mechanical shredding methods - Flaking - Mixing - Careful extrusion with special permission - Roasting - Torrefying - Steaming - Parboiling (rice) - Puffing		- Heat treatment (torrefying, steaming) - Extrusion or heat treatment of milling products (not if final product is also heated e.g. bread)
Bread, pastries (including flour mixes)	- Common dough preparation methods - Deep cooling of dough - Deep cooling of bread and pastries - Baking - Vacuum-baking (vacuum-cooling) - Careful extrusion with special permission (no specification about permission criteria or what “careful extrusion” implies)		- Deep cooling of dough - Added enzymes - Extrusion

Source: own table based on (vgl. Bio Suisse, 2019, pp. 204–209)

Permitted processing aids and additives:
Sour dough starter

- Ferment (from grains, legumes and honey)
- Guar gum
- Baking powder
- Amylases and hemicellulases that break down polysaccharides
- Sodium hydroxide (coating of pretzel products)
- Asparaginase for gingerbread
- Releasing agents:
  - Plant oils and fats
  - Carnauba wax
- Baking powder from:
  - Sodium carbonate
  - Potassium carbonate
  - Ammonium carbonate
  - Magnesium carbonate

…mixed with:

  - Citric or tartaric acid
  - Sodium or potassium tartrate

Table 62 BioSuisse processing regulations for egg products

	Permitted	Prohibited	Labelling
Eggs	- Mechanical cleaning - Screening with light or UV light (usually for roll off traces)		- Only with LGV permitted stamping ink
Fluid egg products	- Crack and separate - Mixing - Homogenization - Pasteurization - Deep cooling	- Pasteurization with microwaves - Use of sulphuric acid - Use of emulsifiers	- Homogenization
Dry egg products	- Crack and separate mixing - Pasteurization - Spray drying	- Use of ant-caking agents - Use of thickening agents	
Cooked egg products	- Mechanical cleaning - Cooking; once, normal pressure - Peeling - Colouring with permitted colours	- Production of long eggs - Multiple cooking - Use of benzoic acid, acetic acid - Use of synthetic colourants	

Source: own table based on (vgl. Bio Suisse, 2019, pp. 210–212)

Permitted colourants:

- Colouring fruit and vegetable juices, their concentrates and powders, colouring spices/herbs and other colouring foods
- Colouring wood and other plant parts
- Colourants that naturally occur in food; physically extracted (e.g. curcumin, carotenoids)
- Plant coal

Cochineal, carminic acid, carmine (coccus cacti extract)

Table 63 BioSuisse processing regulations for spices and herbs

	Permitted	Prohibited	Labelling
Pure spices, spice mixes and extracts	- Cutting - Drying - Grinding - Mixing - Granulation - Extraction with water, ethanol or CO2 - Concentrating and/drying or fluid extracts - Saturated steam and UV-sterilization of spices for further processing or gastronomic purposes - Smoking	- Saturated steam and UV-sterilization of spices for direct trade	- Herbs and spices that make less than 2% of total weight may be listed all together as “herbs/spices” (except those listed in annex 6 of EDI) - Saturated steam and UV-sterilization - Use of anti-caking agents
Dries herbs and herb mixes	- Cutting - Drying - Destemming - Grinding - Mixing - Granulating (max 10% for tea herbs in a bag) - Saturated steam and UV-sterilization of spices for further processing or gastronomic purposes - E 170 and E 504 as anti-caking agents	- Saturated steam and UV-sterilization of spices for direct trade in retail	- Herbs and spices that make less than 2% of total weight may be listed all together as “herbs/spices” (except those listed in annex 6 of EDI) - Saturated steam and UV-sterilization - Use of anti-caking agents
Spice and herb salt mixes	- Mixing - Cutting - Grinding - Drying (incl. vacuum drying) of salt herb/spice mixes - Anti-caking agents: E 170 and E 504		- Herbs and spices that make less than 2% of total weight may be listed all together as “herbs/spices” (except those listed in annex 6 of EDI) - Use of anti-caking agents - For labelling with “Bio Suisse”: 90% of ingredients from Switzerland - Special products for meat processing must be labelled as such
Spice and herb preparations	- Mixing - Cutting - Blanching - Deep cooling - In oil - Mixing with salt - Pasteurization (double only with special permission) - Extraction/decaffeinating of tea with water, ethanol or CO2 - Anti-caking agents: E 170 and E 504	- Double pasteurization without special permission (permission criteria not specified; at the moment no permission is granted; very solid justification needed)	- Herbs and spices that make less than 2% of total weight may be listed all together as “herbs/spices” (except those listed in annex 6 of EDI) - Use of anti-caking agents - Pasteurization
Mustard	- Mechanical shredding/breaking down of mustard seeds - Mixing	No specification	- Herbs and spices that make less than 2% of total weight may be listed all together as “herbs/spices” (except those listed in annex 6 of EDI)

Soy sauce and fluid seasoning	- Roasting and steaming of raw materials - Fermentation - Pasteurization (double with special permission) - Filtration - Pressing	- Acid hydrolysation - Use of flavour enhancers	- Pasteurization - Sterilization
Bouillon	- Production of sauce from dry herbs/starch mixes with fluid if it is not reconstitution - Production of powders and pastes (final product may not seem like it is freshly made) - Mixing - Cooking - Pasteurization - Sterilization - Drying - Concentration	- Reconstitution from concentrates and powders - Use of flavour enhancers	- Pasteurization - Sterilization - Anti-caking agents - Enzymatically hydrolysed plant protein
Soups and sauces	- “Good manufacturing practice” - Production of sauce from dry herbs/starch mixes with fluid if it is not reconstitution - Production of powders and pastes (final product may not seem like it is freshly made) - Use of premade roux - Mixing - Cooking - Pasteurization - Sterilization - Drying - Concentration - Homogenization - Anti-caking agents: E 170 and E 504	- Production of “milk-based sauces” containing more than 10% plant fats - Reconstitution from concentrates and powders - Use of carrageenan, xanthan gum, alginates, modified starches, flavour enhancers	- Pasteurization - Sterilization - Anti-caking agents

Source: own table based on (vgl. Bio Suisse, 2019, pp. 213–219)

Table 64 BioSuisse processing regulations for plant oils and fats

	Permitted	Prohibited	Labelling
Oils for direct consumption	- Common mechanical procedures for cleaning, peeling, preparation – as long as raw material is not heated above 50°C (olive oil 27°C) - Mechanical pressing with an outlet temperature of 50°C (olive oil 27°C) - Roasting (seeds and nuts) - Centrifugation (olive oil max 27°C) - Decanting - Filtration (without asbestos)	- Steaming, deodorizing - Refining - Neutralizing - Bleaching - Extraction with solvents - Use of citric acid, active carbon, sodium hydroxide, bleaching earth. Adsorbents	- Roasting of seeds and nuts
Oils and fats for frying, baking and further processing	- Common mechanical procedures for cleaning, peeling, preparation - Mechanical pressing - Centrifugation (olive oil max 27°C) - Decanting - Filtration (without asbestos) - Removal of mucilage - Deacidification - Washing - Vacuum drying - Bleaching, decolouring - Thermal fractioning - Sterilization (only palm fruits directly after harvest) - Steaming/ deodorizing: - fats for further processing <100°C: steaming only once, max 130°C; tropical fats twice max 190°C - fats for further processing >100°C: no temperature limit for deodorizing	- Extraction with organic solvents - Chemical modification - Neutralization with sodium hydroxide (exception rapeseeds) - Use of phosphoric acid, active alumina, nickel and other catalysts for hydration and transesterification	No specification
Margarine	- Emulsifying - Pasteurization - Crystallization	- Use of hardened fats - Use of colourants, antioxidants, preservatives, aroma	- Use of animal fats - Pasteurization
Mayonnaise	- Mixing and emulsifying - Pasteurization (only for lite products) - Use of enzymatically modified egg yolk and starch only for lite products	Homogenization with pressure (the classical processing method “homogenization” is always done with pressure → generally forbidden; but there are other possible methods to shrink the size of the fat molecules – mostly mechanical, e.g. whisk) - Use of thickening agents - Use of flavour enhancers	- Pasteurization
Salad sauce	- Mixing and emulsifying - Pasteurization	- Homogenization with pressure (see above)	No specification

Source: own table based on (vgl. Bio Suisse, 2019, pp. 220–223)

Table 65 - BioSuisse processing regulations for sweets

	Permitted	Prohibited	Labelling
Sugars and products from sugar	- Common processing methods that comply with Bio Suisse general principles - Hydrolyzation of saccharose with lemon juice or concentrate	No specification	No specification
Jelly and sugar gums	- Mixing - Cooking - Sugar-coating - Drying	- Added flavourings	No specification

Source: own table based on (vgl. Bio Suisse, 2019, p. 233)

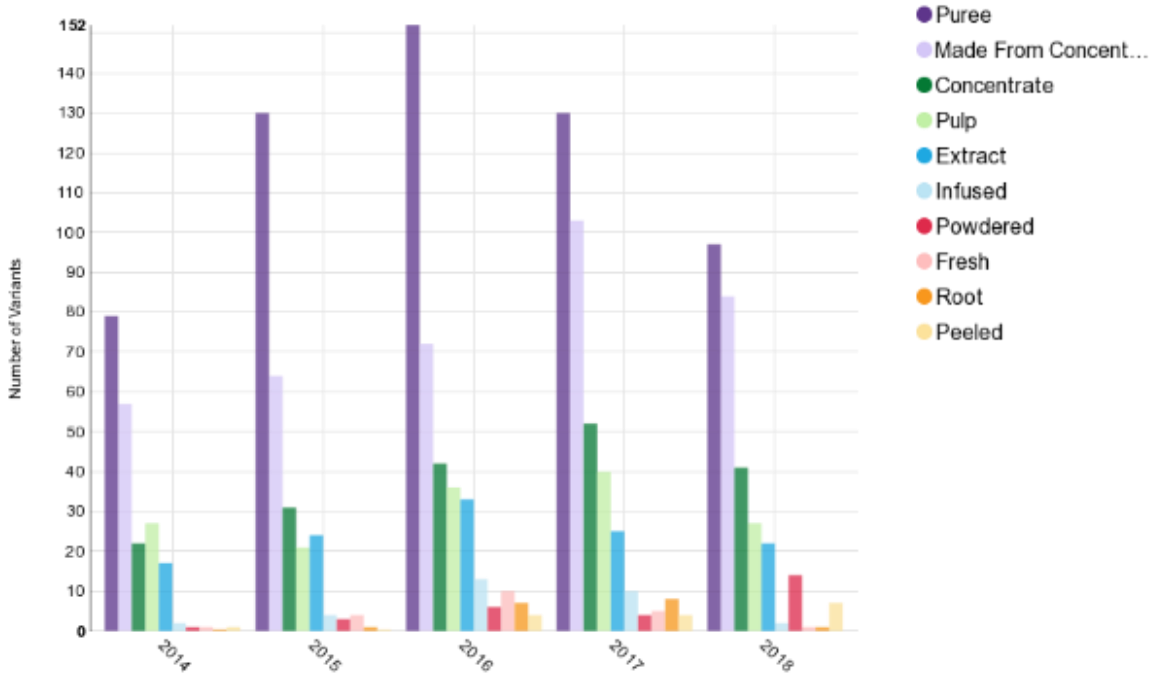
Table 66 BioSuisse processing regulations for coffee, cocoa, chocolate, and other cocoa products

	Permitted	Prohibited	Labelling
Coffee	- Preparation and roasting of coffee beans - Grinding - Extraction - Decaffeinating with water and CO2 - Drying (also spray and freeze drying) - Instantization	- Flavouring	No specification
Cocoa, chocolate and other cocoa products	- Fermentation and drying of beans - Roasting of beans - Breaking and grinding of beans - Deodorization - Alkalization - Pressing (for cocoa butter) - Grinding of press cake - Kneading - Drum rolling - Conching - Crystallizing/tempering - Pressing/forming	- Use of lecithin (exception semi-finished products as instant powders or couverture)	No specification

Source: own table based on (vgl. Bio Suisse, 2019, p. 235)

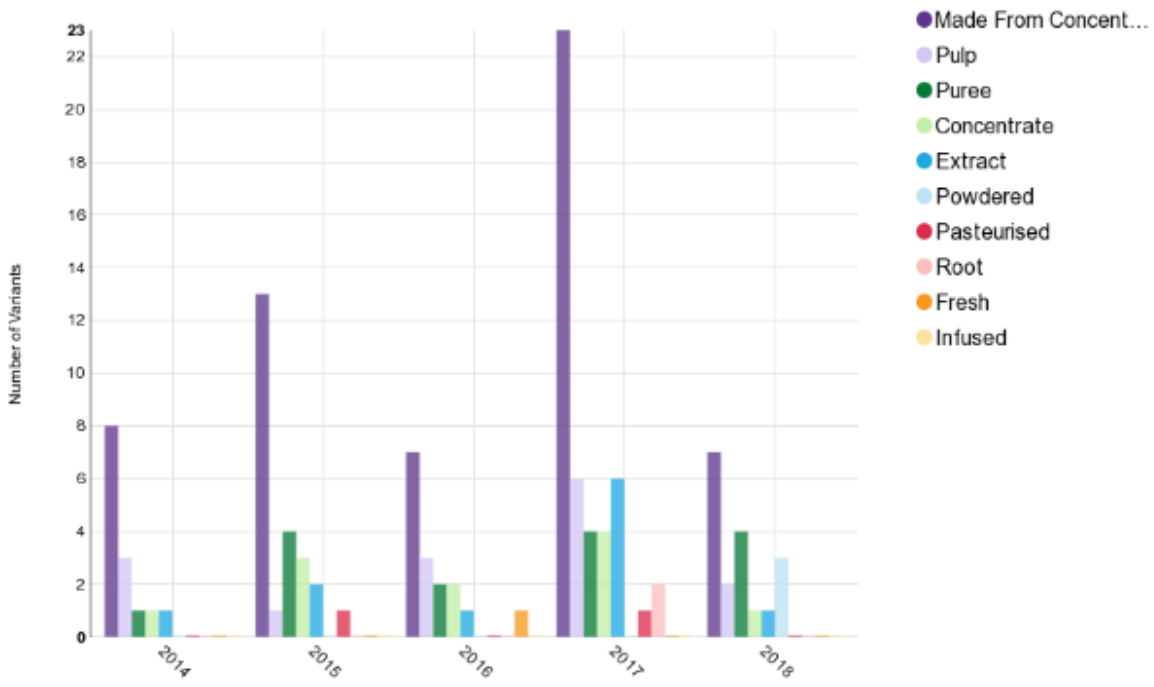
Appendix B

All figures and tables in appendix B are based on MINTEL, database GNPD, from the year 2019.

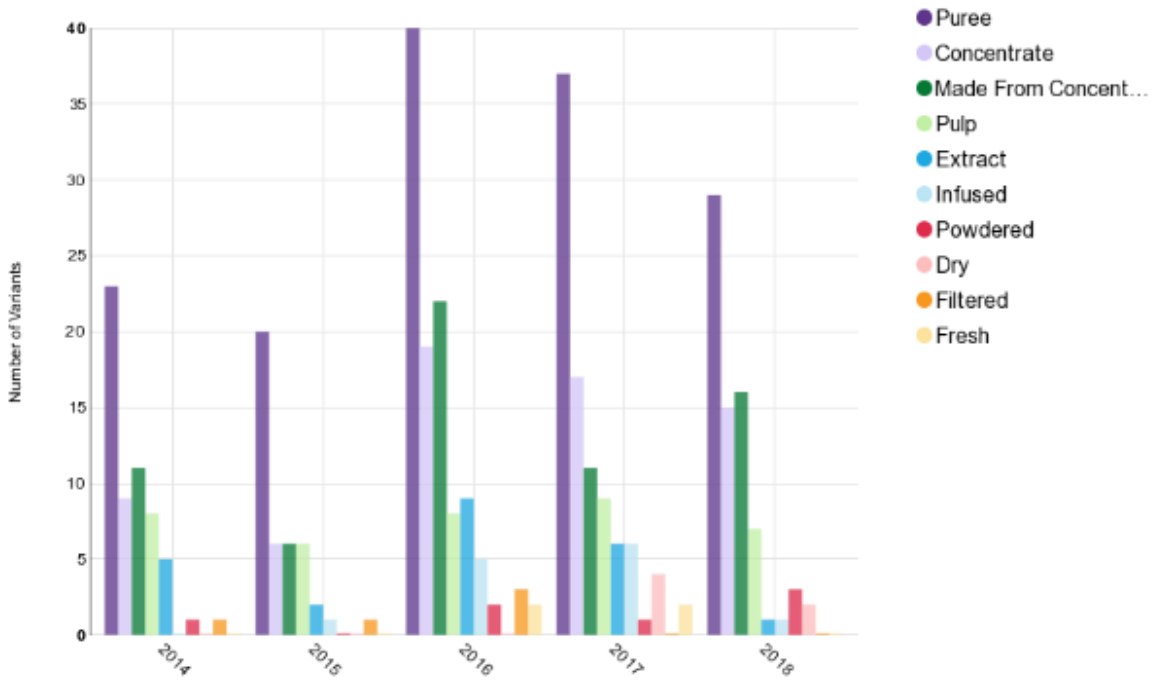


Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Puree	79	130	152	130	97	588
Made From Concentrate	57	64	72	103	84	380
Concentrate	22	31	42	52	41	188
Pulp	27	21	36	40	27	151
Extract	17	24	33	25	22	121
Infused	2	4	13	10	2	31
Powdered	1	3	6	4	14	28
Fresh	1	4	10	5	1	21
Root	0	1	7	8	1	17
Peeled	1	0	4	4	7	16
Total Sample	160	235	281	281	205	1162

Fruit Juice in selected European countries overall

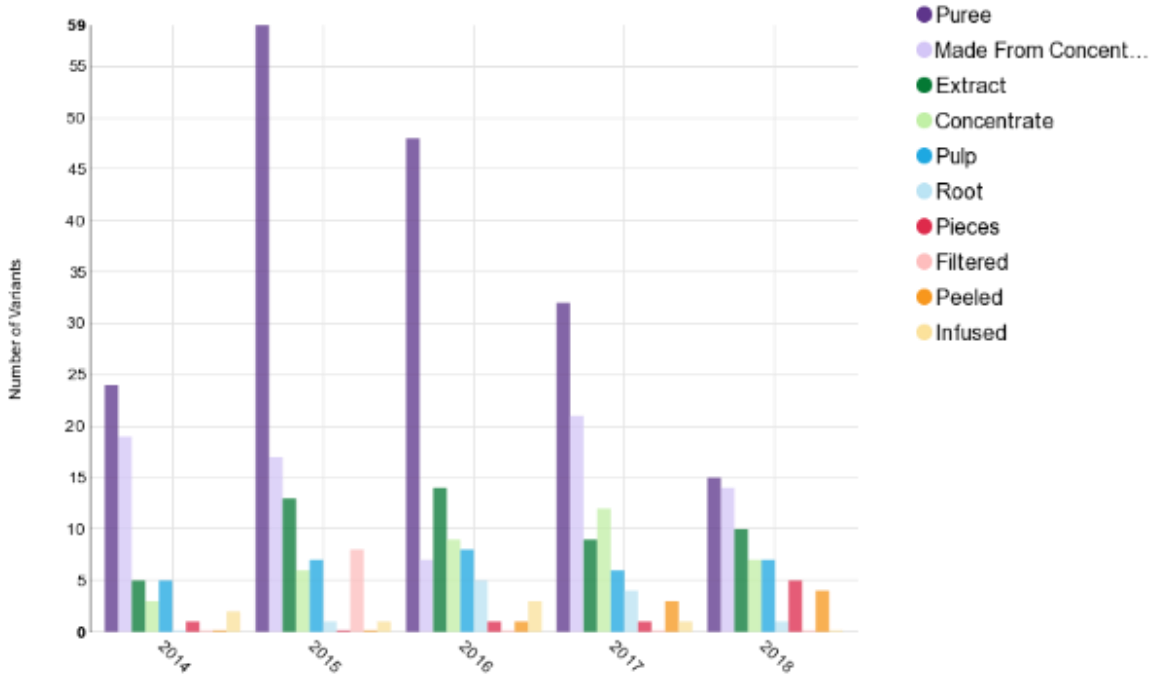


Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Made From Concentrate	8	13	7	23	7	58
Pulp	3	1	3	6	2	15
Puree	1	4	2	4	4	15
Concentrate	1	3	2	4	1	11
Extract	1	2	1	6	1	11
Powdered	0	0	0	0	3	3
Pasteurised	0	1	0	1	0	2
Root	0	0	0	2	0	2
Fresh	0	0	1	0	0	1
Infused	0	0	0	0	0	0
Total Sample	10	21	12	36	10	89



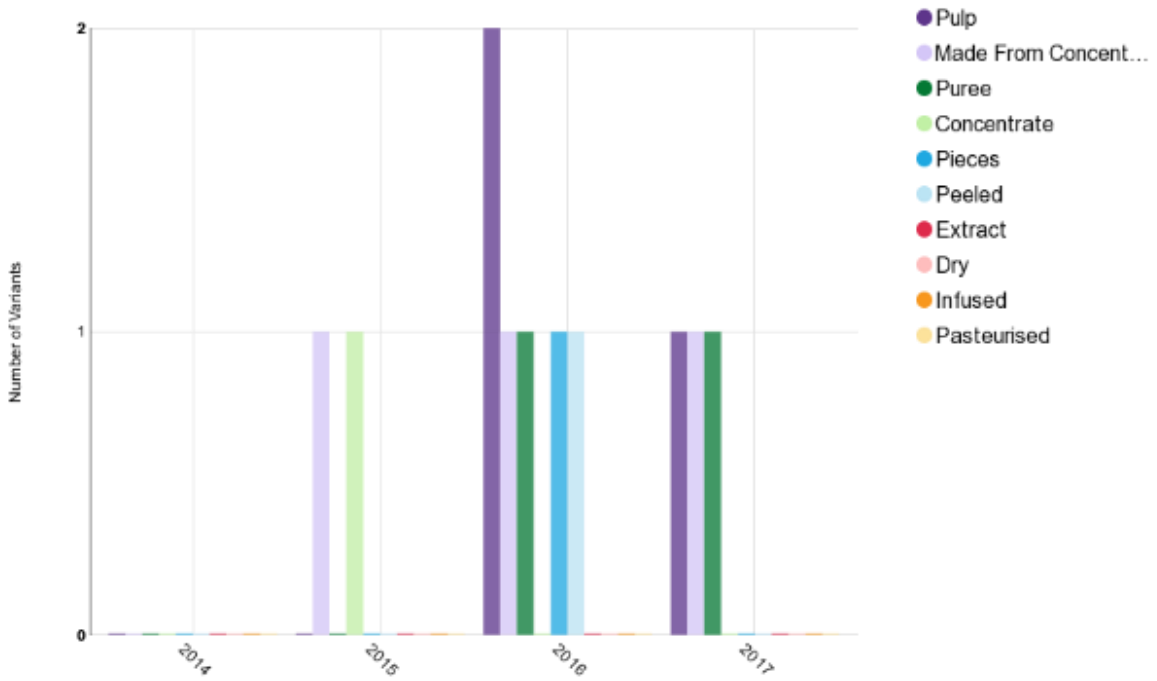
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Puree	23	20	40	37	29	149
Concentrate	9	6	19	17	15	66
Made From Concentrate	11	6	22	11	16	66
Pulp	8	6	8	9	7	38
Extract	5	2	9	6	1	23
Infused	0	1	5	6	1	13
Powdered	1	0	2	1	3	7
Dry	0	0	0	4	2	6
Filtered	1	1	3	0	0	5
Fresh	0	0	2	2	0	4
Total Sample	38	36	78	61	54	267

Fruit Juice in France



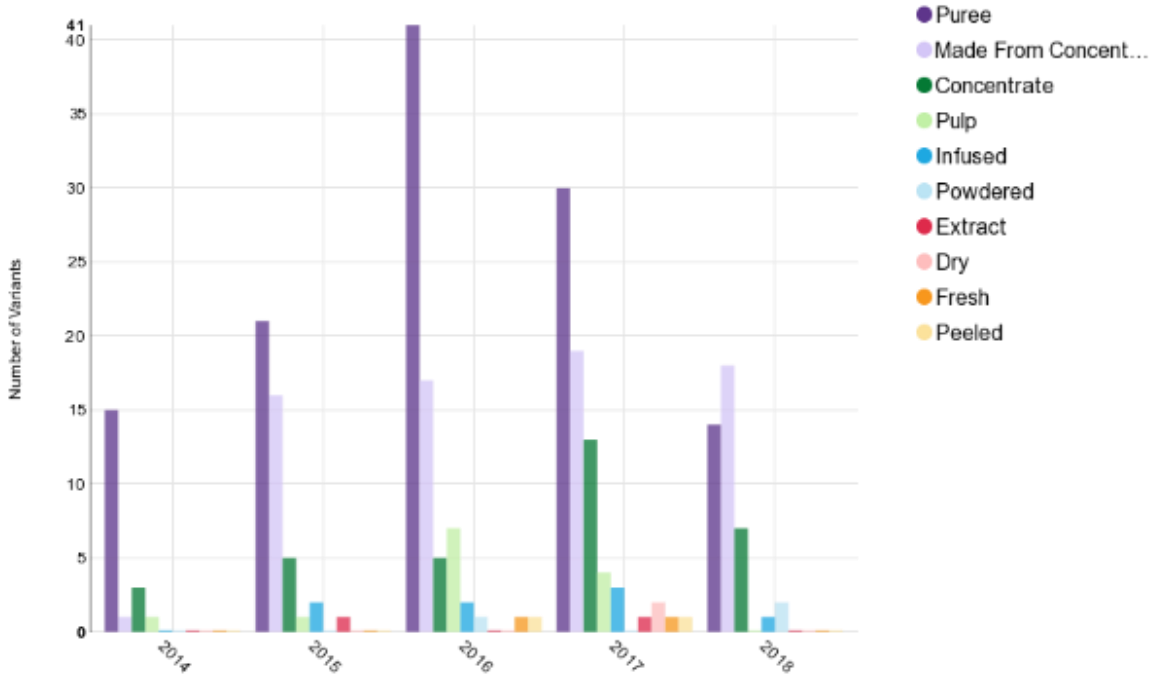
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Puree	24	59	48	32	15	178
Made From Concentrate	19	17	7	21	14	78
Extract	5	13	14	9	10	51
Concentrate	3	6	9	12	7	37
Pulp	5	7	8	6	7	33
Root	0	1	5	4	1	11
Pieces	1	0	1	1	5	8
Filtered	0	8	0	0	0	8
Peeled	0	0	1	3	4	8
Infused	2	1	3	1	0	7
Total Sample	51	94	71	62	41	319

Fruit Juice in Germany

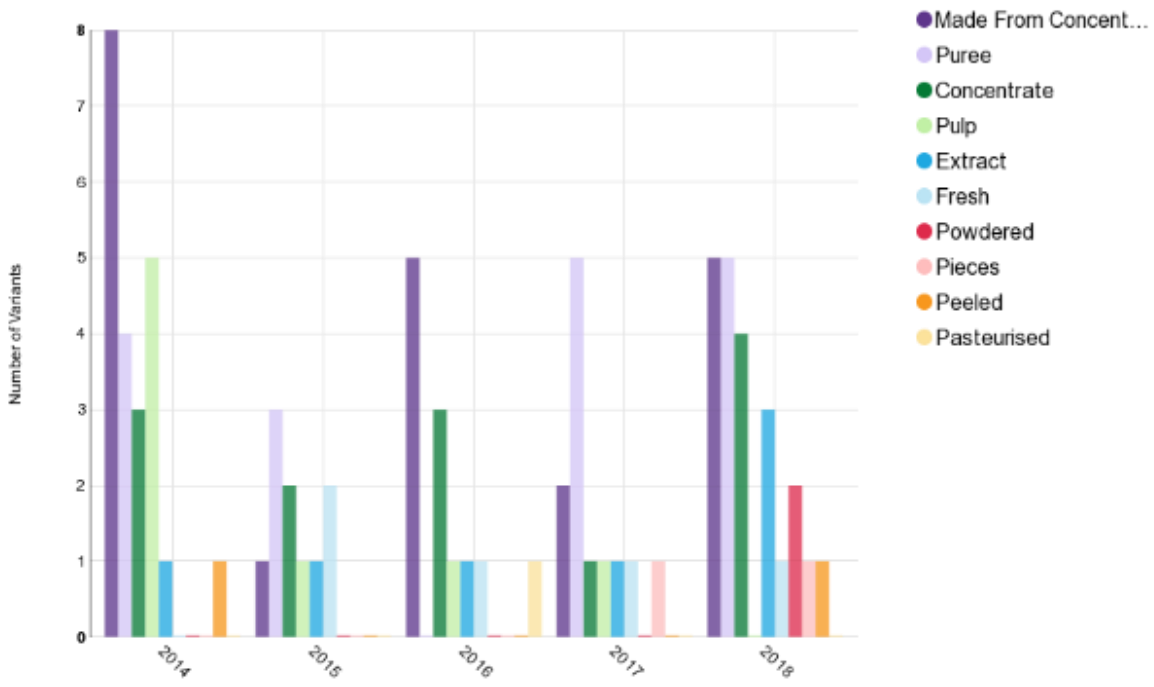


Ingredient Preparation	2014	2015	2016	2017	Total Sample
Pulp	0	0	2	1	3
Made From Concentrate	0	1	1	1	3
Puree	0	0	1	1	2
Concentrate	0	1	0	0	1
Pieces	0	0	1	0	1
Peeled	0	0	1	0	1
Extract	0	0	0	0	0
Dry	0	0	0	0	0
Infused	0	0	0	0	0
Pasteurised	0	0	0	0	0
Total Sample	0	2	4	3	9

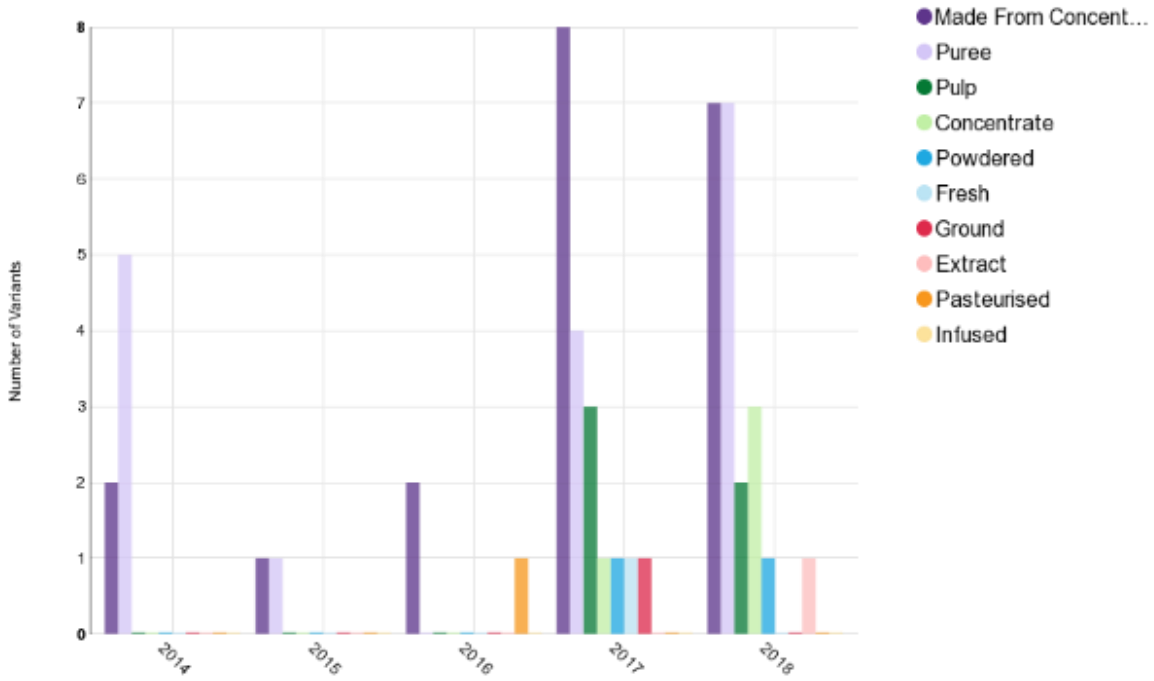
Fruit Juice in Hungary



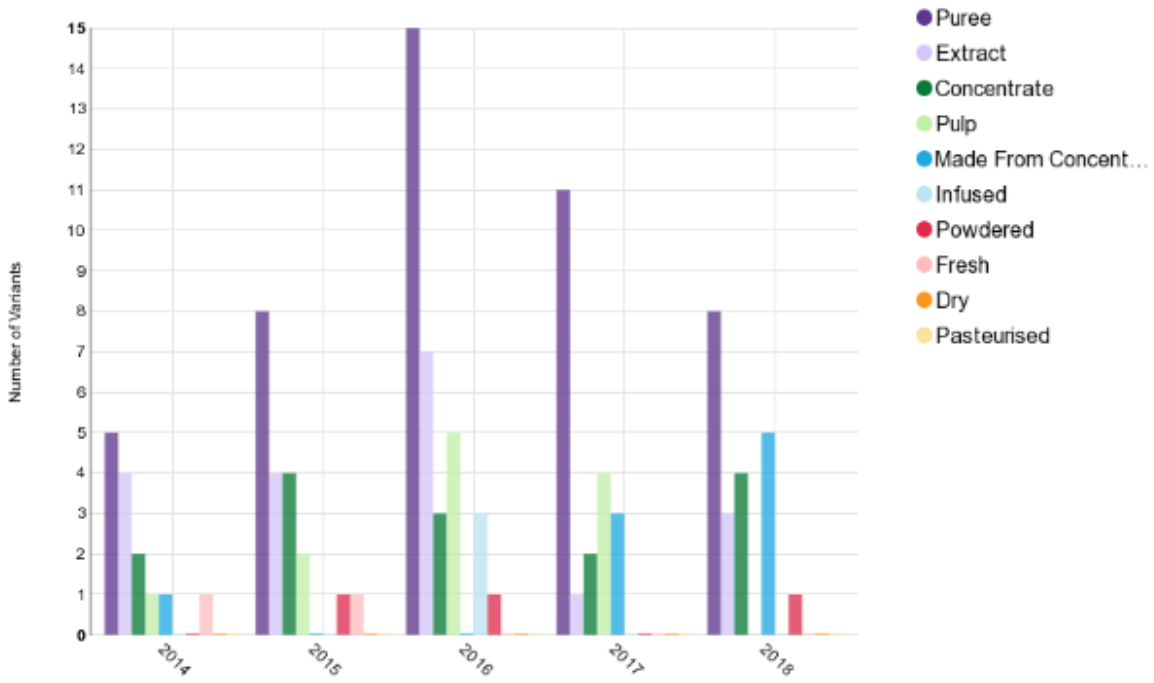
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Puree	15	21	41	30	14	121
Made From Concentrate	1	16	17	19	18	71
Concentrate	3	5	5	13	7	33
Pulp	1	1	7	4	0	13
Infused	0	2	2	3	1	8
Powdered	0	0	1	0	2	3
Extract	0	1	0	1	0	2
Dry	0	0	0	2	0	2
Fresh	0	0	1	1	0	2
Peeled	0	0	1	1	0	2
Total Sample	18	38	58	53	31	198



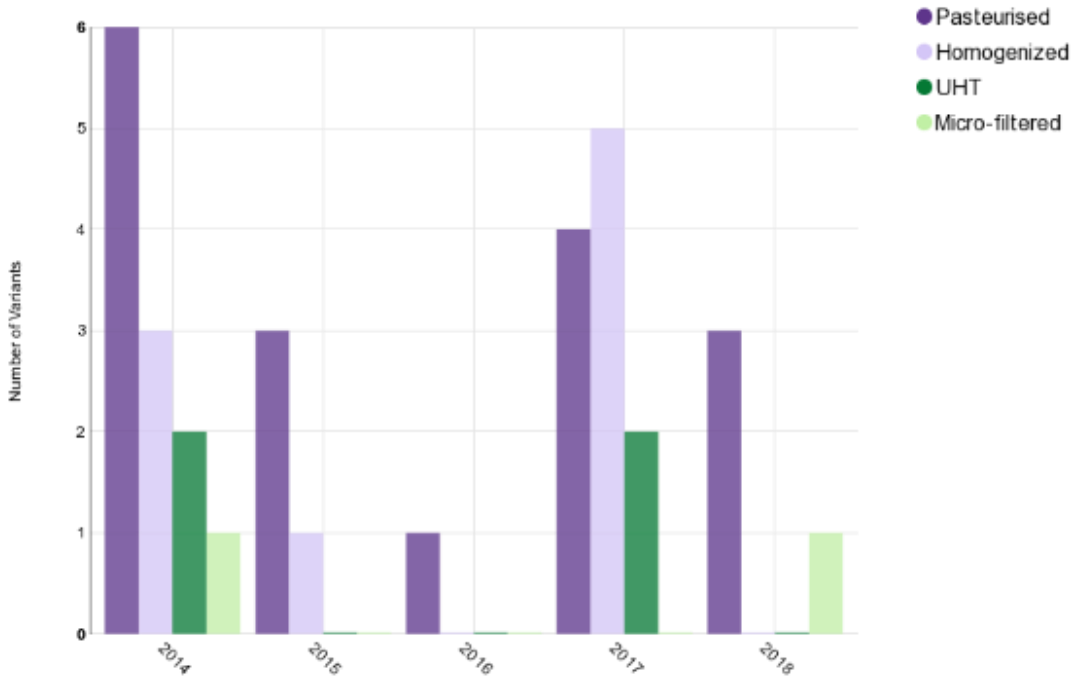
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Made From Concentrate	8	1	5	2	5	21
Puree	4	3	0	5	5	17
Concentrate	3	2	3	1	4	13
Pulp	5	1	1	1	0	8
Extract	1	1	1	1	3	7
Fresh	0	2	1	1	1	5
Powdered	0	0	0	0	2	2
Pieces	0	0	0	1	1	2
Peeled	1	0	0	0	1	2
Pasteurised	0	0	1	0	0	1
Total Sample	14	6	12	10	15	57



Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Made From Concentrate	2	1	2	8	7	20
Puree	5	1	0	4	7	17
Pulp	0	0	0	3	2	5
Concentrate	0	0	0	1	3	4
Powdered	0	0	0	1	1	2
Fresh	0	0	0	1	0	1
Ground	0	0	0	1	0	1
Extract	0	0	0	0	1	1
Pasteurised	0	0	1	0	0	1
Infused	0	0	0	0	0	0
Total Sample	5	1	3	14	15	38

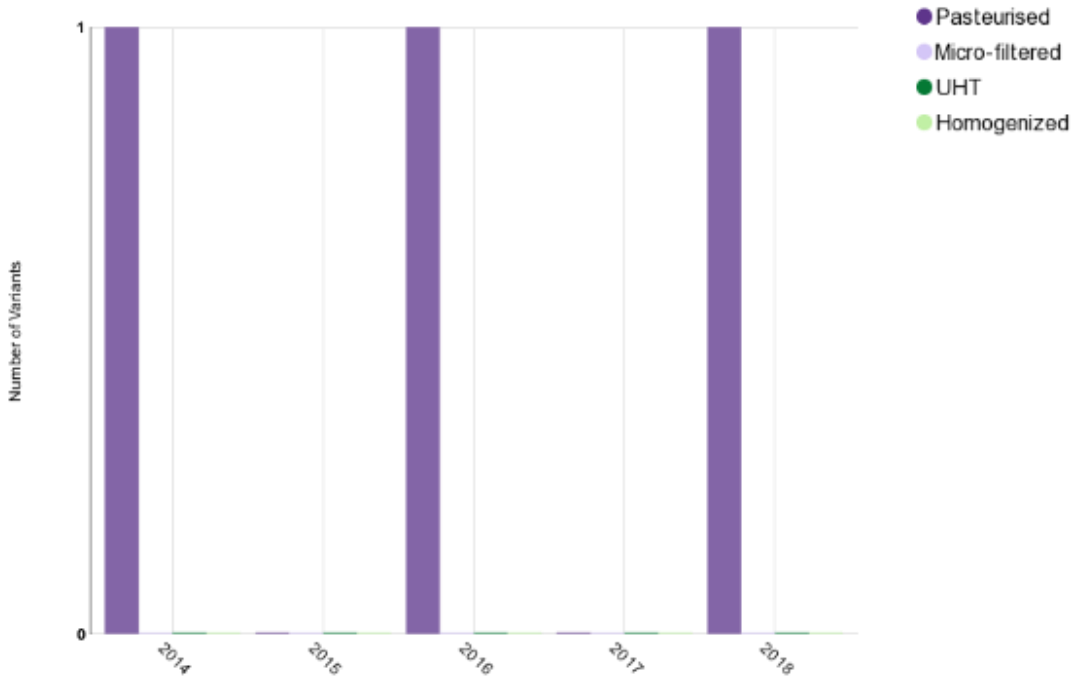


Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Puree	5	8	15	11	8	47
Extract	4	4	7	1	3	19
Concentrate	2	4	3	2	4	15
Pulp	1	2	5	4	0	12
Made From Concentrate	1	0	0	3	5	9
Infused	0	0	3	0	0	3
Powdered	0	1	1	0	1	3
Fresh	1	1	0	0	0	2
Dry	0	0	0	0	0	0
Pasteurised	0	0	0	0	0	0
Total Sample	10	12	21	17	13	73



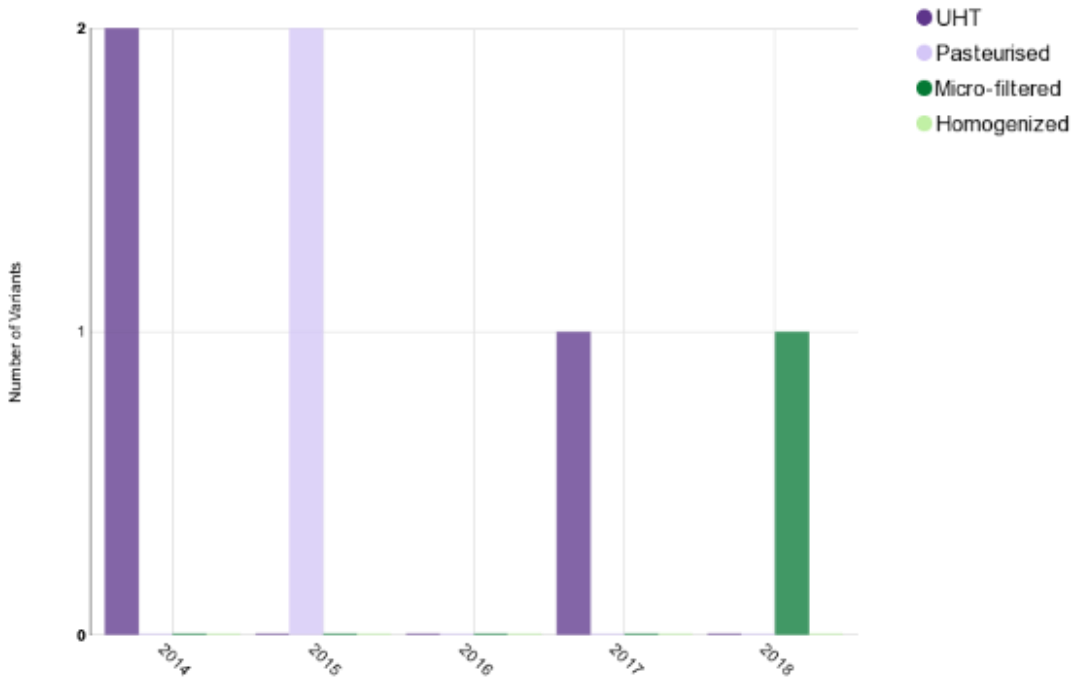
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Pasteurised	6	3	1	4	3	17
Homogenized	3	1	0	5	0	9
UHT	2	0	0	2	0	4
Micro-filtered	1	0	0	0	1	2
Total Sample	8	3	1	6	4	22

Milk in selected European countries overall



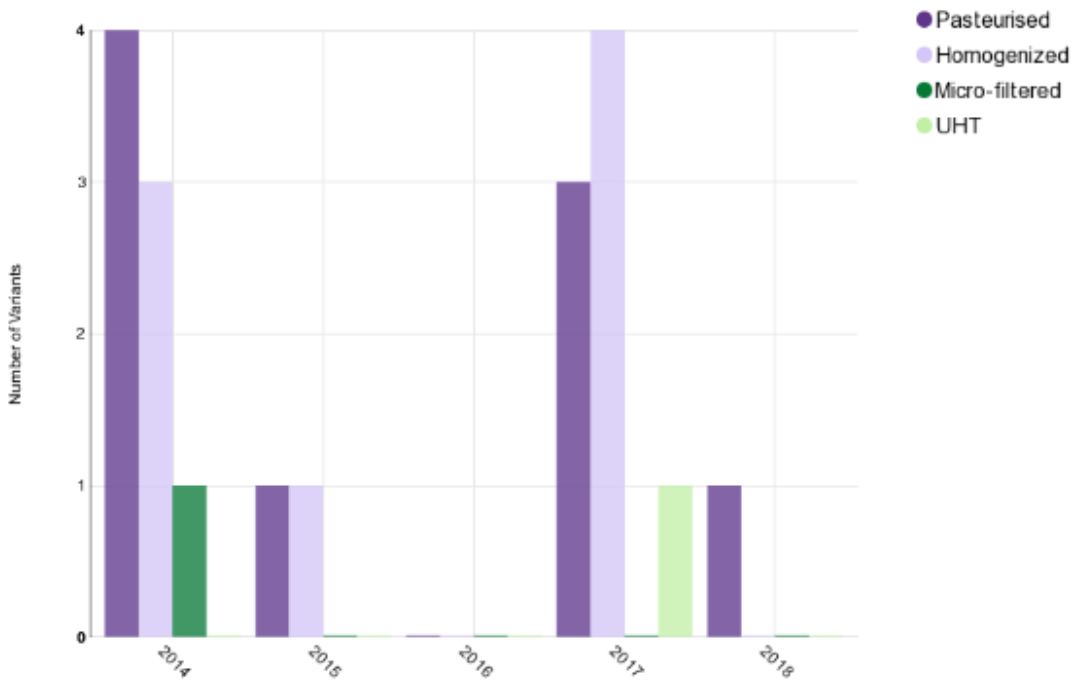
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Pasteurised	1	0	1	0	1	3
Micro-filtered	0	0	0	0	0	0
UHT	0	0	0	0	0	0
Homogenized	0	0	0	0	0	0
Total Sample	1	0	1	0	1	3

Milk in Denmark



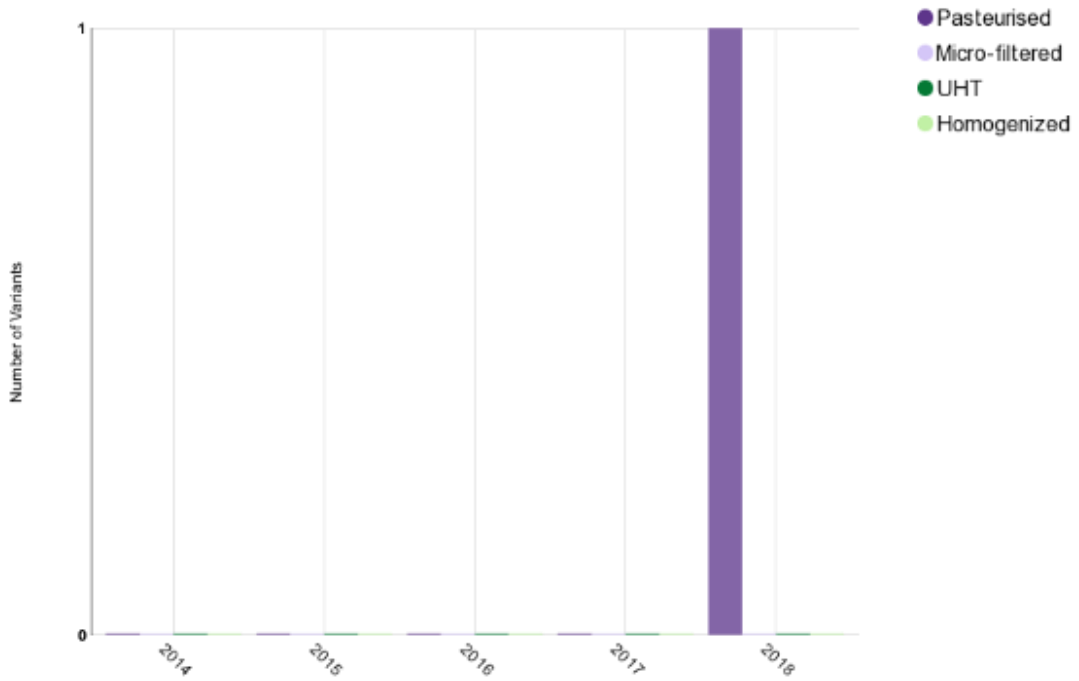
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
UHT	2	0	0	1	0	3
Pasteurised	0	2	0	0	0	2
Micro-filtered	0	0	0	0	1	1
Homogenized	0	0	0	0	0	0
Total Sample	2	2	0	1	1	6

Milk in France



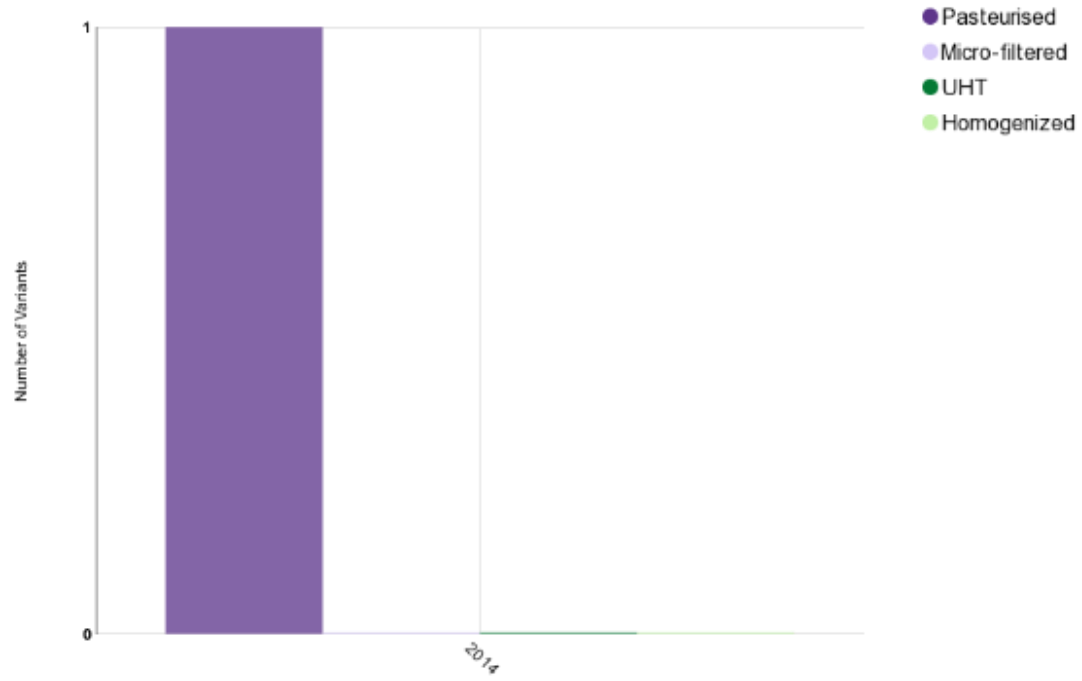
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Pasteurised	4	1	0	3	1	9
Homogenized	3	1	0	4	0	8
Micro-filtered	1	0	0	0	0	1
UHT	0	0	0	1	0	1
Total Sample	4	1	0	4	1	10

Milk in Germany



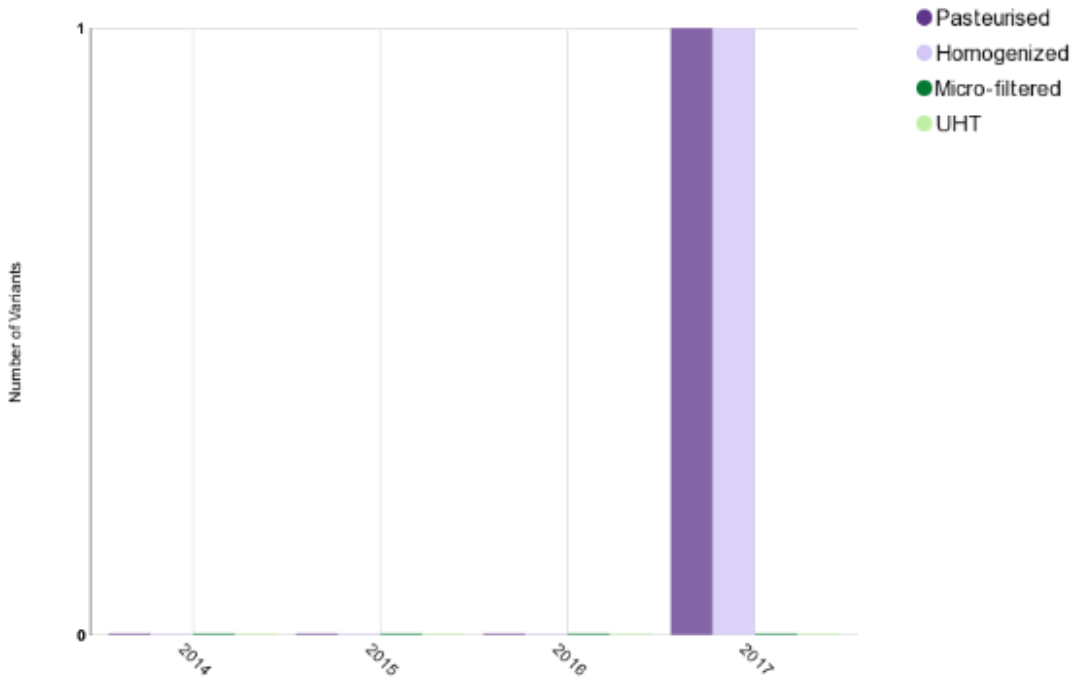
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Pasteurised	0	0	0	0	1	1
Micro-filtered	0	0	0	0	0	0
UHT	0	0	0	0	0	0
Homogenized	0	0	0	0	0	0
Total Sample	0	0	0	0	1	1

Milk in the Netherlands



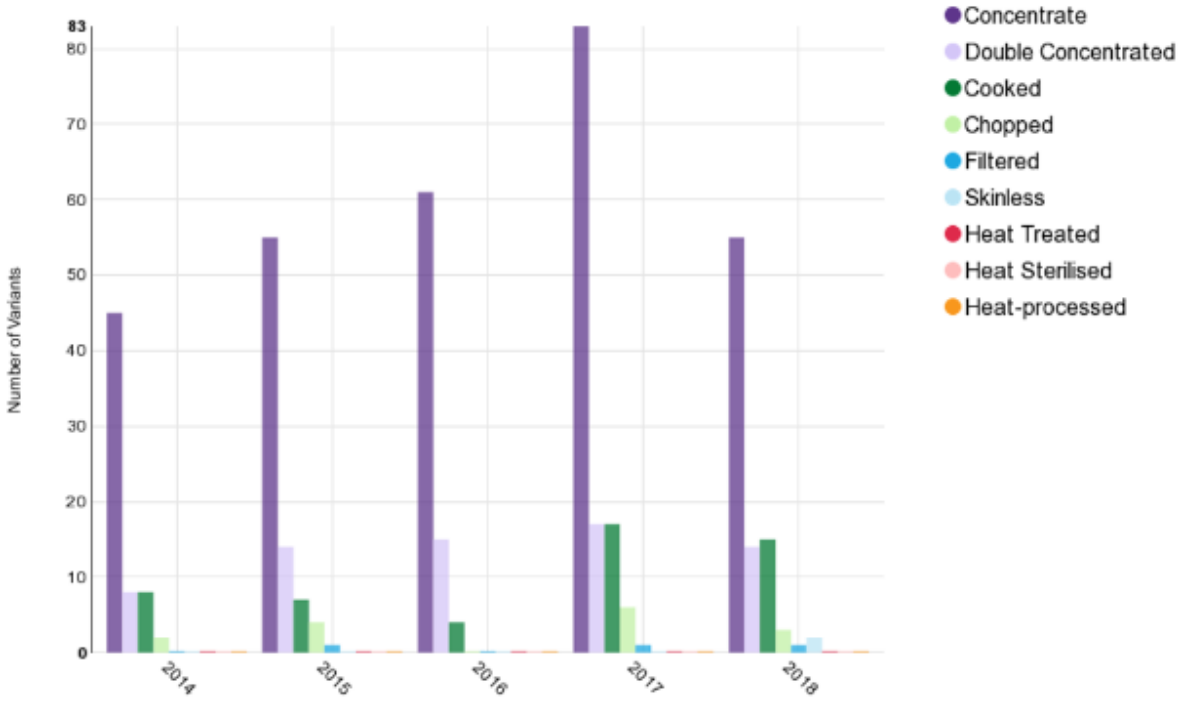
Ingredient Preparation	2014	Total Sample
Pasteurised	1	1
Micro-filtered	0	0
UHT	0	0
Homogenized	0	0
Total Sample	1	1

Milk in Poland



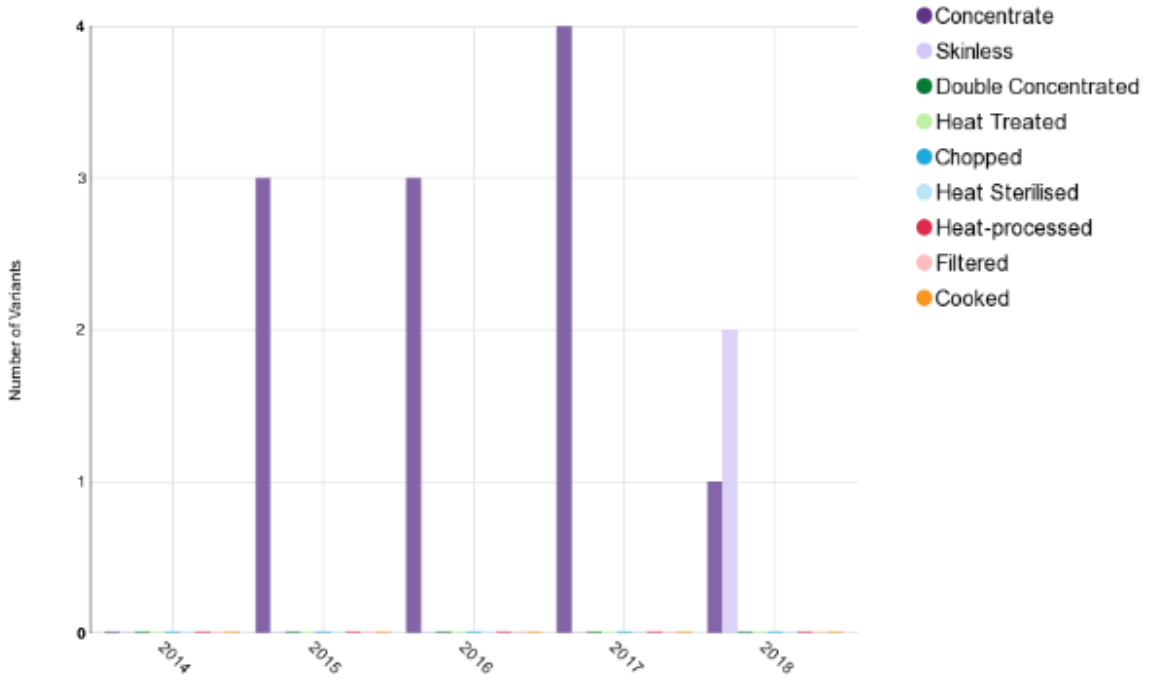
Ingredient Preparation	2014	2015	2016	2017	Total Sample
Pasteurised	0	0	0	1	1
Homogenized	0	0	0	1	1
Micro-filtered	0	0	0	0	0
UHT	0	0	0	0	0
Total Sample	0	0	0	1	1

Milk in Switzerland



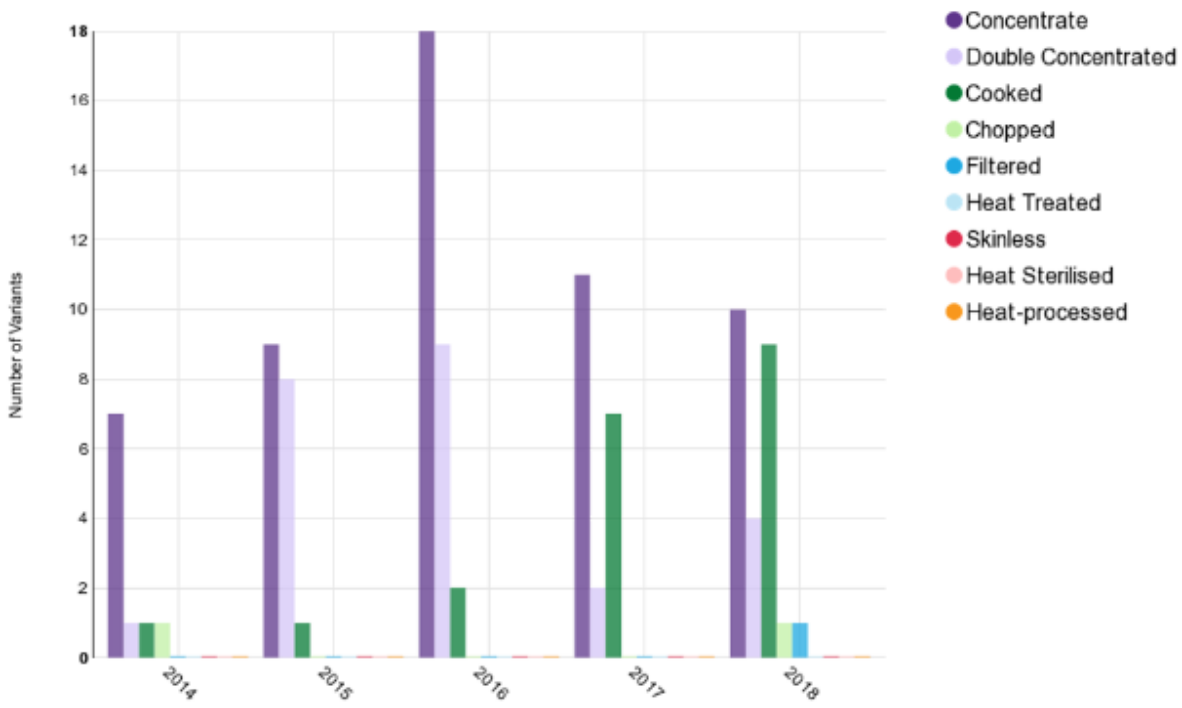
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Concentrate	45	55	61	83	55	299
Double Concentrated	8	14	15	17	14	68
Cooked	8	7	4	17	15	51
Chopped	2	4	0	6	3	15
Filtered	0	1	0	1	1	3
Skinless	0	0	0	0	2	2
Heat Treated	0	0	0	0	0	0
Heat Sterilised	0	0	0	0	0	0
Heat-processed	0	0	0	0	0	0
Total Sample	59	78	76	109	80	402

Tomato puree in selected European countries overall



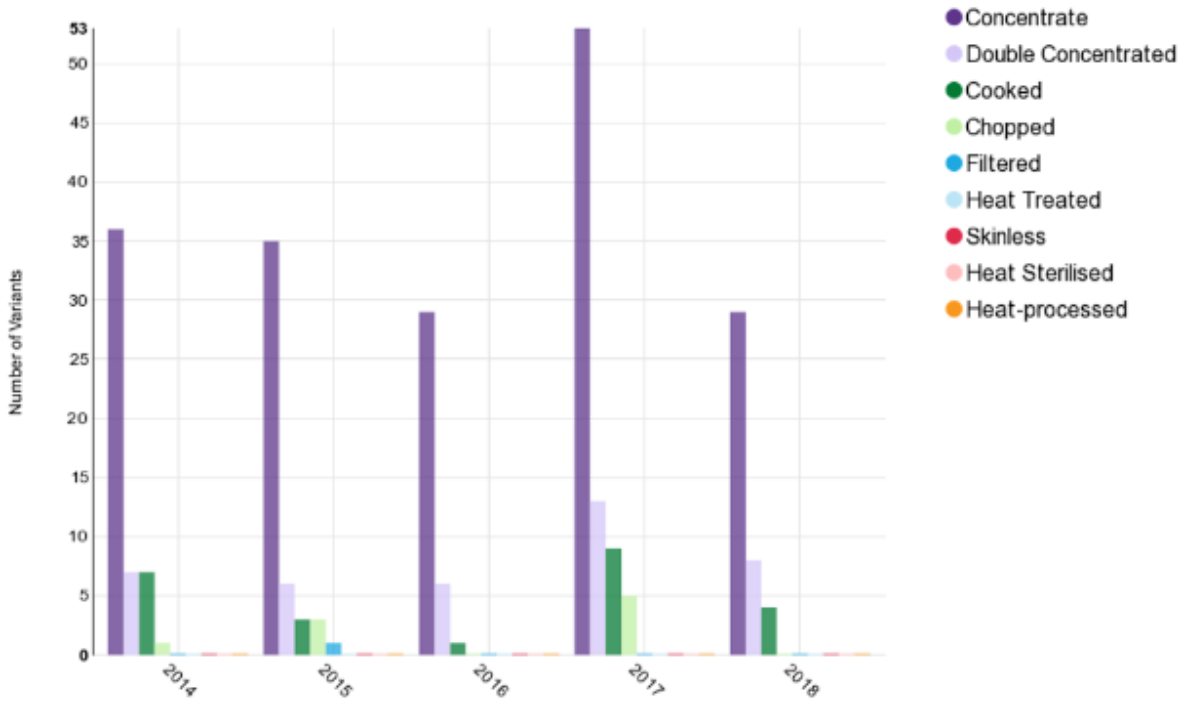
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Concentrate	0	3	3	4	1	11
Skinless	0	0	0	0	2	2
Double Concentrated	0	0	0	0	0	0
Heat Treated	0	0	0	0	0	0
Chopped	0	0	0	0	0	0
Heat Sterilised	0	0	0	0	0	0
Heat-processed	0	0	0	0	0	0
Filtered	0	0	0	0	0	0
Cooked	0	0	0	0	0	0
Total Sample	0	3	3	4	3	13

Tomato puree in Denmark



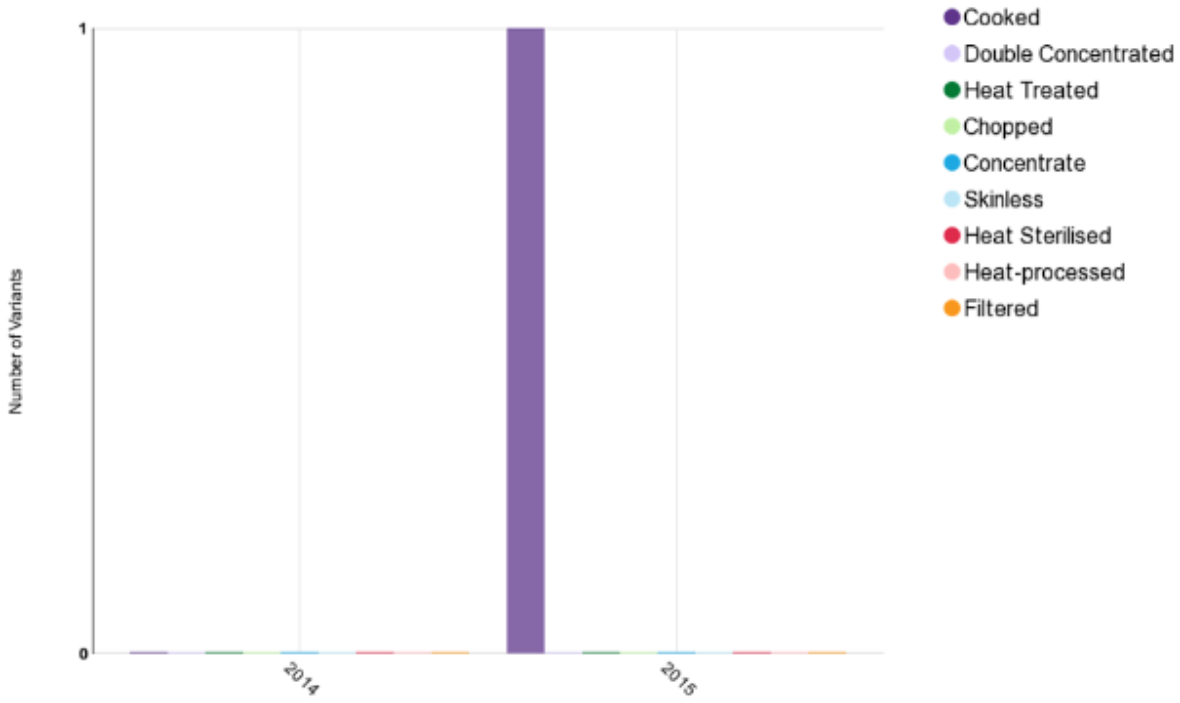
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Concentrate	7	9	18	11	10	55
Double Concentrated	1	8	9	2	4	24
Cooked	1	1	2	7	9	20
Chopped	1	0	0	0	1	2
Filtered	0	0	0	0	1	1
Heat Treated	0	0	0	0	0	0
Skinless	0	0	0	0	0	0
Heat Sterilised	0	0	0	0	0	0
Heat-processed	0	0	0	0	0	0
Total Sample	9	18	27	18	23	95

Tomato puree in France



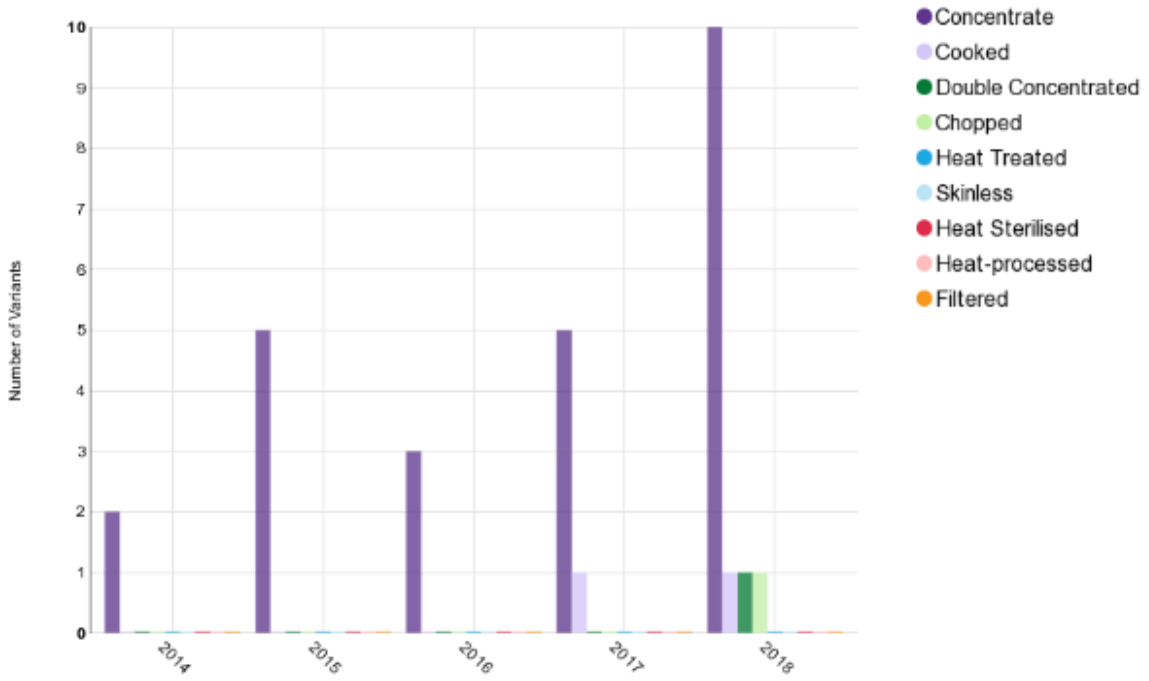
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Concentrate	36	35	29	53	29	182
Double Concentrated	7	6	6	13	8	40
Cooked	7	3	1	9	4	24
Chopped	1	3	0	5	0	9
Filtered	0	1	0	0	0	1
Heat Treated	0	0	0	0	0	0
Skinless	0	0	0	0	0	0
Heat Sterilised	0	0	0	0	0	0
Heat-processed	0	0	0	0	0	0
Total Sample	48	45	34	67	34	228

Tomato puree in Germany



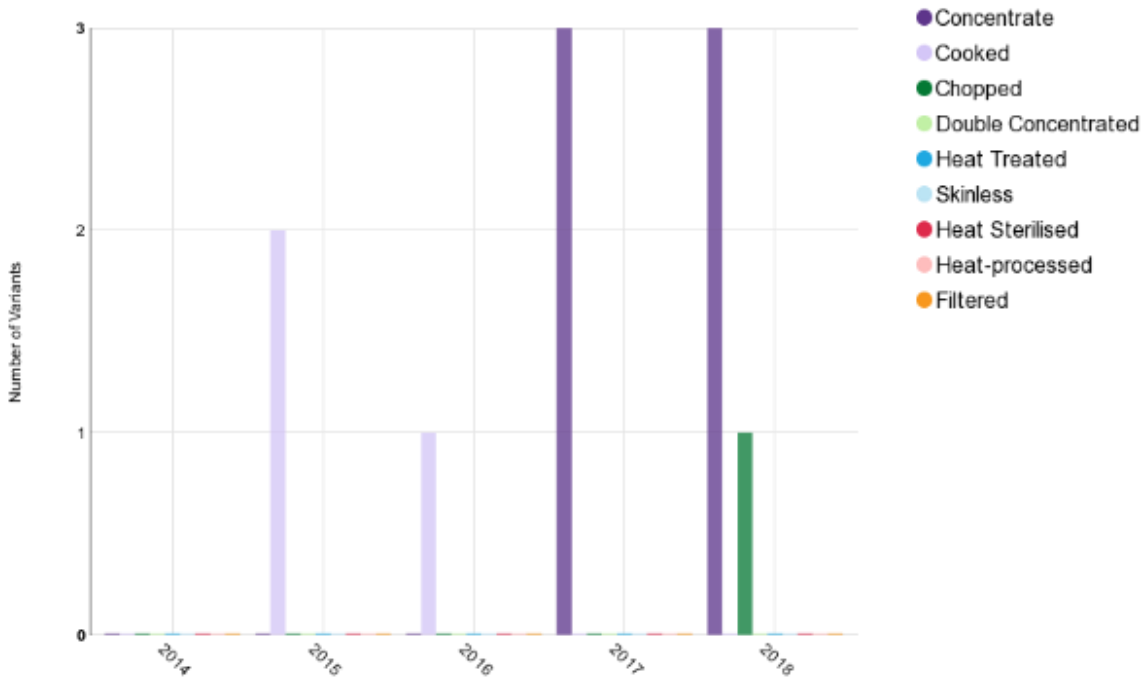
Ingredient Preparation	2014	2015	Total Sample
Cooked	0	1	1
Double Concentrated	0	0	0
Heat Treated	0	0	0
Chopped	0	0	0
Concentrate	0	0	0
Skinless	0	0	0
Heat Sterilised	0	0	0
Heat-processed	0	0	0
Filtered	0	0	0
Total Sample	0	1	1

Tomato puree in Italy



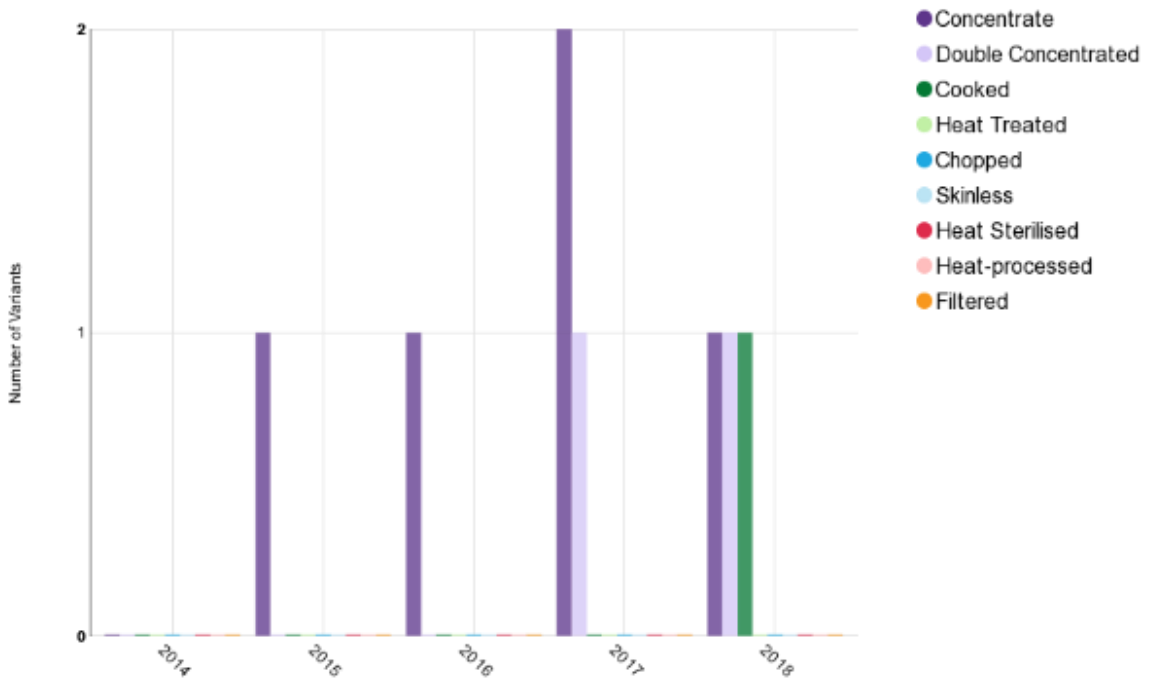
Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Concentrate	2	5	3	5	10	25
Cooked	0	0	0	1	1	2
Double Concentrated	0	0	0	0	1	1
Chopped	0	0	0	0	1	1
Heat Treated	0	0	0	0	0	0
Skinless	0	0	0	0	0	0
Heat Sterilised	0	0	0	0	0	0
Heat-processed	0	0	0	0	0	0
Filtered	0	0	0	0	0	0
Total Sample	2	5	3	6	13	29

Tomato puree in the Netherlands



Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Concentrate	0	0	0	3	3	6
Cooked	0	2	1	0	0	3
Chopped	0	0	0	0	1	1
Double Concentrated	0	0	0	0	0	0
Heat Treated	0	0	0	0	0	0
Skinless	0	0	0	0	0	0
Heat Sterilised	0	0	0	0	0	0
Heat-processed	0	0	0	0	0	0
Filtered	0	0	0	0	0	0
Total Sample	0	2	1	3	4	10

Tomato puree in Poland



Ingredient Preparation	2014	2015	2016	2017	2018	Total Sample
Concentrate	0	1	1	2	1	5
Double Concentrated	0	0	0	1	1	2
Cooked	0	0	0	0	1	1
Heat Treated	0	0	0	0	0	0
Chopped	0	0	0	0	0	0
Skinless	0	0	0	0	0	0
Heat Sterilised	0	0	0	0	0	0
Heat-processed	0	0	0	0	0	0
Filtered	0	0	0	0	0	0
Total Sample	0	1	1	3	2	7

Tomato puree in Switzerland

PRORG

COORDINATOR

CREA (ITALY)

PARTNERS

DENMARK (KU)
FRANCE (ACTIA, INRA, ITAB)
GERMANY (AÖL, FH MU, TI)
ITALY (ASOBIO, CREA, UNIVPM)
POLAND (WULS)
SWITZERLAND (FIBL)
THE NETHERLANDS (WUR)

CORE organic