

Quality of organically grown protein crops in Norway for livestock concentrates – limited N and S supplementation

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Key words: Oilseed crops, concentrates, pea, rape, turnip rape, camelina

Abstract

The aim of organic farming husbandry, is to be entirely based on an organically produced diet. Shortage of organically produced protein crops for production of concentrates supplying the European market, and a contemporary ban on the use of fishmeal for ruminants in the EU has lead to an increased need for organically produced feedstuffs for production of concentrates in Norwegian organic husbandry. Pea is the most common cultivated protein-rich crop in organic agriculture in Norway. For ruminants, peas has a low bypass protein content compared to common protein supplements such as rape meal and soybean meal. Other high-protein crops with complementary properties are therefore needed to meet the demand in feed quality for ruminants, pigs and poultry. Oilseed crops, which are rich in both fat and protein, will become of considerable interest if problems related to their cultivation are solved. Currently, our experience with oilseed crops in organic agriculture is limited. In a four year research project "Organic protein feed and edible oil from oilseed crops" this experience will be extended and the feed quality of organically grown protein crops like rape, turnip rape and camelina will be evaluated. The project will provide knowledge about the rumen degradability of protein, starch and NDF (neutral detergent fibre) and intestine digestibility of protein and starch in organically grown protein-rich crops necessary for the production of concentrates with an optimal feed quality.

Introduction

The content of crude protein is often low in the herbage from an organic ley (Olberg *et al.*, 2005), resulting in insufficient protein content to meet the nutritional demands of e.g. high productive milking cows. Therefore feedstuffs with additional protein are normally added to the ration. Husbandry in organic farming should be based entirely on an organically produced diet (Council for The European Union, 1999). An obstacle in the production of concentrates for use in organic farming is that extracted soybean meal, which is the main protein source in conventional concentrates, is not permitted in organic husbandry. This is caused by a general ban on the use of chemical extraction in fodder production (www.debio.no). Fish meal has been a vital constituent in concentrates and secured the need for high-quality proteins in organic husbandry. However, precautions to avoid contamination with prions from meat bone meal, and high prices, have made it important to look for alternatives. Currently, pea is the most

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common cultivated protein-rich crop in organic agriculture in Norway. For ruminants, peas has a low bypass protein content compared to common protein supplements such as rape meal and soybean meal (Corbett, 1997). Other high-protein crops with complementary properties are therefore needed to meet the demand in feed quality for ruminants, pigs and poultry. Oilseed crops, which are rich in both fat and protein, will become of considerable interest if problems related to their cultivation can become solved.

The content of chemical constituents such as protein, fat, NDF (neutral detergent fibre) and amino acids varies among crops. In addition, nutritional quality parameters like fatty acid composition and rumen degradability of protein varies much among crops as well. High rumen degradability of protein result in a low AAT-value (amino acids absorbed in the small intestine) and a high PBV-value (Protein balance in the rumen) (Madsen *et al.*, 1995). Turnip rape and rape are rich in unsaturated fatty acids, which restrict the content of oilseeds that can be used in the daily feed ration for ruminants. However, the content of oilseeds in the ration can be increased if fat is removed through squeezing or compression. In addition, expeller cakes produced in that way usually have an increased protein value for ruminants because the heat produced in the treatment reduces the rumen degradability of protein, increasing the AAT-value and reducing the PBV-value of the feed. Moreover, the oilseeds are rich in S-containing amino acids, complementing the amino acids found in peas. Unfortunately, the mentioned crops do also contain elements which different animal species have different tolerances for (Wollenweber *et al.*, 2002). Camelina or gold-of-pleasure (*Camelina sativa* L. Crantz) is another oil-seed crop, which may have considerable interest for organic cropping in northern areas (Alen *et al.*, 1999). It has a low nutrient requirement, no seed dormancy, less problems with insect damage than rape and turnip rape and the seed quality makes it actual both for edible oil and animal feed (Vollmann *et al.*, 1996).

Experiments with conventionally grown oilseeds crops show great difference in protein and fat content according to the N fertilization rate (Rathke *et al.*, 2004; Asare & Scarisbrick, 1995). Currently, our experience with oilseed crops in organic agriculture is limited, and we do not know to what extent limitations in the N supplement will influence the content of crude protein and fat. In addition, N and S application have increased the seed glucosinolate concentration (Asare & Scarisbrick, 1995). Different fertilization strategies may perhaps result in differences in the feed quality. Experiment with long-term cattle manure application to rape increased the total N content and decreased the oil content in seed (Hao *et al.*, 2004).

Our ongoing project "Organic protein feed and edible oil from oilseed crops" involve the whole production chain for protein feed and edible oils and will obtain knowledge for secure production of high-quality proteins for livestock feeds and edible oil for human consumption in Norwegian organic farming based on oilseed crops. One of the sub-goals in the project is to establish knowledge on the feed quality of organically grown protein crops. The project will provide knowledge about the rumen degradability of protein, starch and NDF and intestine digestibility of protein in organically grown protein-rich crops in order to plan the production of concentrates for the Norwegian organic husbandry in the future. The project period is 2006 to 2010.

The project is lead by the Norwegian Institute for Agricultural and Environmental Research in co-operation with the Norwegian University of Life Science, the Swedish University of Agricultural Sciences, the Norwegian Institute for Land Inventory, the Norwegian Meteorological Institute, Norwegian food research institute - Matforsk and

the companies 'Felleskjøpet Fôrutvikling BA', 'TINE produsentrådgivning' and 'Norsk Matrap AB'. This presentation gives an overview of the project and gives some preliminary results from the first year.

Materials and methods

In the main project, fields with peas, spring sown green manure and barley will be established as pre-crops for turnip rape and camelina in the spring of 2006, 2007 and 2008 on the organic research area at Research Farm Apelsvoll and at Lanna Research Station, in the spring 2007 and 2008. For winter rape and winter turnip rape, fields with spring sown green manure crop of white clover (*Trifolium repens*), ryegrass (*Lolium* spp.) and phacelia (*Phacelia tanacetifolia*), and barley will be established as pre-crops in the same years. Split-plot experiments with four nitrogen levels (0, 40, 60 and 80 kg ha⁻¹ in organic fertilizer) on main plots and turnip rape and camelina with and without S (MgSO₄) on sub-plots will be placed in each pre-crop field with three replications in 2007, 2008 and 2009 at Apelsvoll and at Lanna in 2008 and 2009. Split-plot experiments in winter rape and in winter turnip rape with autumn fertilization (0 and 40 kg N ha⁻¹, chicken manure pellets) on main plots and spring fertilization (0, 40, 60 and 80 kg N ha⁻¹ chicken manure pellets with and without S) on sub plots will be placed in each pre-crop field in 2006, 2007 and 2008 at Apelsvoll and in 2007 and 2008 at Lanna. Each experiment will have three replications. At each experimental site, weather data like air and soil temperature, precipitation and time of snow cover is recorded. The mineral N content for each treatment will be determined in late autumn in the establishing year and after harvest.

Samples of rape, turnip rape, camelina and pea from the respective fields is sampled and analysed chemically for ash, starch, protein, fibre, NDF (neutral detergent fibre), fat, sugar, the amino acids methionine, lysine, cysteine, tryptophan, threonine and arginine and the minerals Ca, P, Mg and S. Rumen degradability of protein and NDF and intestine digestibility of protein in rape, turnip rape, camelina and pea will be analysed with nylon bag methods (Madsen *et al.*, 1995). For pea, also the rumen degradability and intestine digestibility of starch will be analysed with nylon bags. Content of fat and protein, rumen degradability and intestine digestibility of protein will be determined in samples from both expeller cake and entire seed from camelina, rape and turnip rape. Glucosinolate concentration will be analyzed in camelina, rape and turnip rape, while tannins concentration will be analyzed in pea. Samples will be analysed according with the methods used in Nordic Feed Evaluation.

Discussion and results

Autumn 2006, pea samples (varieties Faust, Integra and Pinochio) from six different farms were analysed chemically for ash, starch, protein, NDF (neutral detergent fibre), fat, fibre, Ca, P and Mg. The results from the analyses were quite comparable to results from conventional studies, but new samples will be analysed in winter 2007 and 2008 until a full evaluation of the results can be performed. In the 2006 varieties of Faust and Pinochio, rumen degradability of starch, protein and NDF, and intestine digestibility of starch and protein were analysed with nylon bag methods (Madsen *et al.*, 1995). The protein degradability in the two samples was lower than estimated in

Norwegian feed table for 2008, but within normal variation. This was also the case for starch and NDF. The degradability of starch in pea was lower than in oat and barley, which is of special interest concerning high yielding dairy cows. The measurement of intestine digestibility of protein and starch show unexpected high values of indigestible portion of starch (39% of total) and protein (13% of total). This might be due to the analytical technique, and will be further investigated. However, lower digestibility of starch than protein is in agreement with studies on conventional peas (Ljøkjel *et al.*, 2003a, b).

We expect a pronounced variation in the quality of protein-rich crops dependent on the cultural measures, soil fertility and climatic conditions. The results from the different quality parameters will be evaluated in comparison to published results and former feeding trials with conventionally grown rape, turnip rape and pea. Quality-parameters of significance for the use of crops in the production of concentrate for ruminants and poultry will be prioritized.

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