Technical Note 3

ICOPP

Improved Contribution of Local Feed to Support 100% Organic Feed Supply to Pigs and Poultry

Fulfilling 100% organic pig diets: Concentrates

Introduction

The main dietary challenge for pig producers is ensuring that feed fulfills the nutrient requirements of pigs, in particular with regards to protein and the correct amino acid profile. This is a particular challenge for organic pig producers as the use of synthetic amino acids is not allowed. There has been a derogation from the EU Organic Regulatory Board to allow organic pig and poultry producers to include up to 5% non-organic feed within their rations to assist in meeting the nutritional requirements of the birds. This derogation was due to finish at the end of December 2014 but has now been extended to 31 December 2017 when it will become compulsory under EU Regulations (EC) no 889/2008 to provide all organic livestock with feed derived from 100% organic origins. This guide discusses the potential of locally-sourced protein sources as viable alternative ingredients in pig concentrate diets.

See ICOPP Technical Note 4 for information on feeding roughage and foraging from the range.

Protein and amino acid requirements of swine diets

Protein nutrition of the pig is concerned primarily with supplying the amino acid requirements for fast, efficient growth and development of a lean carcass. The most limiting amino acids are lysine, tryptophan, threonine, and methionine (Table 1).

Lysine is generally the first limiting amino acid in almost all practical diets, so if diets are formulated on a lysine basis, the other amino acid requirements should be met. Lysine requirements vary throughout the production stages of pigs. As pigs mature their amino acid requirements decline.

Phase-feeding a series of diets with reducing protein and amino acid content as the pigs develop has the potential to increase productivity. Diets should be formulated on a digestible amino acid basis rather than on a total amino acid or crude protein basis. These dietary formulation strategies are more accurate than feeding the same diet at all stages of development, resulting in cost savings and a reduction of the environmental impact as they improve feed conversion efficiency and, therefore, reduce excretion of surplus nitrogen (N).

Table 1. Protein/amino acid requirements of sows and growing pigs (90% Dry Matter)

	Gestating sows	Lactating sows	Growing pigs (Kg) fed ad-lib					
Protein %	12.4	17.5	26.0	23.7	20.9	18.0	15.5	13.2
Lysine	0.54	0.91	1.50	1.35	1.15	0.95	0.75	0.60
Tryptophan	0.11	0.16	0.27	0.24	0.21	0.17	0.14	0.11
Threonine	0.44	0.58	0.98	0.86	0.74	0.61	0.51	0.41
Met+Cystine	0.37	0.44	0.86	0.76	0.65	0.54	0.44	0.35

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Potential protein sources from plants

Oilseeds

Concentrates derived from oil seeds are well established ingredients in organic pig diets. Oilseeds including soya beans (a legume often classed as an oilseed) require processing to remove the oil content from the seeds.

Soya beans

Soya bean is covered here as it is often classified as an oilseed although it is a legume that fixes nitrogen to the soil (it therefore has the advantages and disadvantages, including anti-nutritional factors, discussed below in the section on legumes). Soya bean is a very popular source of protein in monogastric diets due to its high nutritional value and protein digestibility. The crude protein and digestible lysine content of soya bean expeller is 43.5% and 2.66% respectively. Current feeds often make use of soya bean imported from South America, India and China. European-produced soya bean meal seems to be the most promising, sustainable, alternative to imported soya bean meal. However, production would be likely to be confined to Southern parts of Europe as, although soya beans grow in a range of soil types, they require a long growing season and ample sunshine. It is possible that selecting high yielding varieties with an ultra-short growth season could maximise European production.

Oil seed rape

Rape seed expeller has a crude protein and digestible lysine content of 32% and 1.54% respectively. High concentrations of anti-nutritional factors (ANF), specifically glucosinolates and uric acid, which affect palatability and reduce intake levels, limit inclusion rates of rape in pig rations.

However the development of 'Canola' (oil seed rape low in both glucosinolates and uric acid) provides a more suitable variety for organic pig diets. Canola protein concentrate can be used in pig diets at an inclusion level up to 10%. At this inclusion level the content of glucosinolates in the diet is below the advised maximum level of 3 mmol glucosinolates per kg diet.

From a crop production viewpoint, rape needs to be strategically placed in an organic rotation due to the high risk of attack from insect pests and weeds and, being a relatively hungry crop, it can be difficult to grow with regards to crop-nutrition.

Sunflower seeds

Dehulled sunflower seed expeller can be a very useful ingredient for fulfilling the digestible lysine requirement in swine feed. Sunflower meal does not contain ANFs such as those found in soya bean and oil seed rape. In sunflower seed products the crude protein and digestible lysine content is largely affected by the presence of intact hulls, ranging from 21.4% and 1.04% respectively in sunflower seed expeller with hulls to 38.3% and 1.23% respectively in the dehulled variant.

From a crop production viewpoint, sunflowers are drought tolerant and can be grown on a wide range of well-drained soil types. Sunflowers are relatively easy to produce under organic conditions and can be grown quite widely in Europe.

Legumes

Legume concentrates e.g. beans (*Vicia faba*), peas, lupins and chickpeas, can significantly contribute to the protein/amino acid supply of organic pig diets, although the anti-nutritional factors which they contain have to be taken into account.

Peas and beans

Peas and beans are good options for protein supply in organic pig diets due to their high protein content (17-35%) and because organic cultivation is widely practiced across Europe. White-flowering bean and pea varieties are promising potential ingredients because they contain a low amount of tannins and are often low in trypsin inhibitor activity (TIA). White-flowering winter peas show fourfold higher TIA than spring types. Therefore the choice of the cultivar is important. Beans with low tannin content can be used in piglet diets at an inclusion rate up to about 20%. Pea protein concentrate can be used in piglet diets at an inclusion level up to at least 8% and even more provided a low TIA content.

Regions with suitable climatic conditions for pea and bean production (Mediterranean and warm coastal regions) could increase production by implementing an autumn-spring cycle. The protein yield is reasonable, but should be further improved to make pea or bean production a real alternative for the farmer. Because of the sensitivity of these legumes to pathogens and pests, however, a rotation period of at least 5 years has to be taken into account.

Lupins

Lupins have a lower content of protein and ileal digestible amino acids than does soya bean meal. Moreover, the ratio between ileal digestible methionine and ileal digestible lysine is lower in lupins than in soya bean meal. However, sweet lupin seeds (low-alkaloid varieties) containing approximately 37% protein and lacking in TIA, can make a valuable contribution to pig rations on-farm since high temperature cooking to eliminate anti-nutritional factors is not needed. Such low alkaloid lupins can be used in piglet diets at an inclusion level of 10%.

Forage legumes

Lucerne

Lucerne is a forage legume crop that produces 2,400 kg of protein per hectare on the basis of 13 tonnes of dry matter with an average of 19% of crude protein as compared to 800 kg of protein per hectare for soya bean. The disadvantage of lucerne compared to pulses and (oil) seed protein sources is that the leaf material contains a lot of water. Bio-refinery techniques might increase the potential uses of lucerne by separating the protein and fibre fractions, but these techniques should be further developed before they can be applied in practice.


Lucerne

Sainfoin seeds

Sainfoin seeds are a promising, highly palatable, protein/amino acid source for poultry and other non-ruminants when compared with soya bean. Sainfoin seeds with hulls intact/dehulled contain 27.9 and 38.8% crude protein respectively. Trials with piglets fed a 16% dehulled sanfoin seed diet, substituted for soya bean cake or peas, showed no significant differences in feed conversion ratio or weight gain suggesting that the sainfoin was a viable alternative to these more commonly used ingredients. With regards to production, sainfoin thrives on free draining, alkaline and calcareous soils (pH6.2 or above). It is not suitable for production on moisture-retentive or acidic ground.

Cereals

Oats (with a crude protein content of 12-15%) are a very robust crop that complements organic farming practices. Oat crops are well adapted to cultivation in North-West and Eastern Europe. The amino acid composition of oats is superior to that of other cereals due to their higher amount of limiting amino acids like methionine, lysine and threonine and, thus, oats can be used as a high quality protein source in diets for young piglets.

Other protein sources

Algae

Algae have a favourable amino acid profile compared with other sources of protein including soya. With a crude protein content ranging from 25% to 50%, algae could make a useful addition to maintaining crude protein/amino acid profiles in swine diets. While not currently certified as organic, the ability to produce a protein source tailored to specific amino acid profiles presents an opportunity for further exploration as a sustainable alternative protein source. It is conceivable that greater demand for such products would lead to economies of scale and subsequent reductions in cost as at present algae production is most likely to be small-scale and costly.

Earthworms

Earthworm meal has a crude protein content ranging from circa 58% DM to circa 71% DM, depending on species, and an amino acid profile similar to that of fishmeal. The development of organic vermiculture (earthworm farming) systems is a realistic option and is thought to be possible all-year round throughout Europe. It is a potentially sustainable method of protein production for organic poultry, where any waste products can be collected and recycled to land. The contaminant content of the feedstock would need to be closely monitored for high levels of heavy metals and dioxins but if managed correctly the process should have minimal environmental impacts.

Leaf material

Leaf material left over as a by-product from processing of crops like sugar beet, cassava, lucerne or grass, could also be used as a source of protein for swine feed. The protein content is relatively low (about 12%), but refining of plant waste material for protein production could be a sustainable way of utilising all biomass from a crop.

Concentration of protein sources

Further processing of ingredients, thereby reducing the levels of anti-nutritional factors (ANFs) and increasing the protein content to levels of 65% or higher, would help to fulfil the need for high quality lysine rich proteins.

The concentration method currently used on organic soya beans, which involves cracking, dehulling, steam conditioning, flaking and a defatting process by expelling oil using a screw process, could be used for other oilseeds such as sunflower and sainfoin, increasing their crude protein levels from circa 23% to 50-70%. An example of such a processed oil seed is Canola (rape seed) protein concentrate, which contains 77% standardised ileal digestibility (SID) crude protein and an SID lysine content of 1.33%.

Dehulled sunflower seed expeller has a digestible lysine content of 1.04% which can be further increased to 1.23% when the crude fibre content is reduced from 16.7% to 6.4%.

Dry fractionation, usually milling followed by air classification, is a means to concentrate the protein content of legumes. Three fractions are obtained: fractions enriched in fibres, starch and proteins. The enriched protein fractions can then be collected for utilising in diets. Common figures for peas and faba beans indicate enrichment to about 60-70% of protein by this process. Peas are high in lysine, and the digestible lysine content of pea protein concentrate can be 5.5% (Table 2).

The dry fractionation process used on legumes can also be used on oats, although the starch granules of oats are much smaller. This may hamper the separation of the starch from the proteins, and hence may result in a lower protein content of the protein enriched fraction.

The concentration process for leaves involves grinding, squeezing out the protein rich juice by mechanical pressing and recovering the protein from the juice by heating it to precipitate the protein. The resulting leaf protein concentrates range from 50% to 90%.

Table 2. Nutritional value for pigs of peas, beans (Vicia faba), rape seed, soya bean and sunflower seed concentrates.

	Peas	Beans *Vicia faba*	Rape seed meal	Soybean meal	Sunflower seed meal	Oats
NE (MJ)	11.2	9.55	6.29	8.25	5.51	
SID* Protein (%)	83.5	39	77	93	80	65.9
SID Lysine (%)	5.5	1.98	1.33	2.55	0.83	3.4
SID Met+Cys (%)	1.19	0.41	1.10	1.15	0.99	1.6ł
SID Threonine (%)	2.74	1.06	0.99	1.51	0.87	3.1
SID Tryptophan (%)	0.62	0.21	0.30	0.52	0.30	

*standardised ileal digestibility, which considers minimum losses, is used as the best measure of digestibility.

ł methionine only

Forage/roughage

Forage can make a valuable contribution to nutrition at all stages of pig development, offering a source of minerals and vitamins, enhancing feed intake and supporting gut health. It is estimated that grazing gestating sows require up to 60% less additional feed compared with sows that do not have access to grazing. Gestating sows can consume 1.5-1.6 kg silage per day with a dry matter (DM) content of 26%.

Foraging on lucerne (alfalfa) has the potential to contribute to growing pigs' protein needs, supplying up to 20% of total daily DM intake thereby contributing to increasing the resource efficiency of forage based systems for organic growing pigs.

Organic housed growing and finishing pigs were able to realize 6% of DM intake during the starter phase and 15% during the grower phase by consuming grass silage. However, extending the finishing period may be necessary to obtain optimum slaughter weight in this system.

Conclusions

Several options are available to fulfil the requirement of 100% ingredients of locally produced organic origin in organic pig concentrate diets, but if the practical, economic and environmental foot print issues are taken into account, then the list of current options is quite small. The range of options varies with the different climatic conditions throughout Europe with more limited options in the northern areas than in the south.

Within the category of plant ingredients, oilseeds, and in particular European-produced soya bean meal, seem to be the most promising long term alternative to imported soya bean meal. However production is limited to southern areas of Europe. Sunflower seeds and rapeseed have potential as widely available protein crops due to the high value of extracted oil for other markets.

Within the category of legumes, peas, beans and sainfoin seeds seem to be a viable option because of their relatively high protein content and good availability.

Some aquatic proteins, e.g. algae, might be a valuable protein source for pigs in the future. More research is required to investigate developments regarding larger scale production, costs, organic certification, feed safety, and legislation.

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