Acta Agraria Kaposváriensis (2011) Vol 15 No 2, 11-21
Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

# Considerations on feeding pigs with by-products – the Danish Experience

**R.I. Svarrer, E. Vils**
Danish Agriculture and Food Council, Pig Research Centre

***ABSTRACT***

*In Denmark, by-products have been used for years with positive outcome. Demand is increasing for by-products for use in feed for livestock. In order to ensure that productivity does not drop significantly when switching to feed containing by-products, a risk analysis should be completed. In Denmark, years of experience, a multitude of nutrient analyses and feeding trials constitute the basis of recommendations for the use of by-products in feed.*
(Keywords: pig, by-products)

***ÖSSZEFOGLALÁS***

**Sertések melléktermékekre alapozott takarmányozásának feltételei: a dán gyakorlat**
Svarrer, R.I., Vils, E.
Danish Agriculture and Food Council, Pig Research Centre

*Dániában évek óta sikeresen alkalmazzák a melléktermékeket. A kereslet (igény) folyamatosan nő a takarmányozásban felhasználható melléktermékek iránt. Annak érdekében, hogy a termelés ne csökkenjen jelentősen, ha mellékterméket tartalmazó takarmányt etetnek, kockázatelemzést kell végezni. Dániában az elmúlt években felhalmozódott gyakorlati tapasztalatok, a megannyi elvégzett kémiai vizsgálat és takarmányozási kísérlet megteremtette az alapját egy, a melléktermékek takarmányozási célra történő felhasználására vonatkozó ajánlás megalkotásának.*
(Kulcsszavak: sertés, melléktermék)

## INTRODUCTION

Every year, Danish pig production buys large quantities of by-products for feed-use. These are liquid as well as dry by-products; liquid by-products are used directly on farms where liquid feeding is practised, and dry by-products are used either directly on farms practising on-farm mixing of feed or in ready-mixed feed purchased from a feedmill. Liquid by-products are often sold to farms located nearby to keep transport costs low. Producers of by-products will have to decide whether they will be able to sell the products locally or whether the by-products need drying in order to be sold further away.

As the institution responsible for the Danish feed evaluation system (*Tybirk et al.,* 2004) and feedstuff database (*Vils et al.,* 2005; *Svarrer et al.,* 2009; *Sloth and Vils,* 2010), Pig Research Centre (PRC) has many years of experience in evaluating the suitability of by-products in pig feed. Evaluations include a risk analysis of the by-product in question, establishment of standard values and feeding- and digestibility trials. The evaluation is based on the basic idea of composition of pig feed; to fulfil the

pigs' requirement in terms of nutrition and health, to comply with statutory requirements and to minimise the discharge of N and P to the surrounding environment.

This paper will provide an outline of the elements included in such an evaluation. A general description will be provided with a specific example with rape products. Rapeseed meal and cake have been used in pig feed since the 1980s, but interest in these products is increasing these days due to an increase of production in Europe following the use of rapeseed oil as biofuel and as prices of grain and soybean meal is soaring.

**Evaluation of by-products as feedstuffs**

By-products are residual products from food and non-food industries. By-products may originate from the production of food, for instance discarded and rejected foodstuffs, but also from production of non-food such as biofuel and pharmaceuticals. By-products can be of both vegetable and animal origin. By-products originate from all sorts of products of varying origin and from different production processes. Though not all, many by-products are suitable as feed, and it should be evaluated whether the product is suitable as feed in terms of energy content and nutrients and whether the by-product matches the expected value of the good (the Danish Plant Directorate, 2010). Examples of by-products:

- From the oil industry: e.g. rape-, sunflower-, soybean meal and cake.
- From the food industry: e.g. whey, mash, molasses, beet pellets, wheat bran, discarded goods etc.
- From the pharmaceutical industry: e.g. brewer's yeast.
- From the ethanol industry: e.g. DGS, DDGS, wheat bran.

A great deal of information can be obtained of the by-product by checking the process from ingredient to by-product – which ingredients are included, how are they processed and stored?

*What type of product is it?*

The evaluation of a by-product should include an investigation of the basis of the product. Does the by-product originate from production of food or non-food? In the non-food industry, focus on feed as well as food safety may be limited. Does the by-product contain animal ingredients? Pigs and poultry may only be given products based on fish, but no other animal protein.

It is important to know where the by-product is produced, which ingredients it consists of and their origin. Note that legislation in non-EU countries may differ from EU legislation for instance when it comes to limit values for ingredients that are undesirable in feed and in terms of additives allowed in feed. Often, producers make specific quality requirements to the products that may influence the quality of the by-product. These may be requirements for specific content in the ingredient, maximum limits for harmful substances or requirements for drying and storage that minimise the risk of damaging the product during storage and formation of toxins.

*Rape*. Rapeseed contains a certain amount of anti-nutritional factors. Rapeseed for use in feed must be of the double-low varieties with the lowest possible content of anti-nutritional factors (*Maribo,* 2010). In double-low varieties, the seeds have a glucosinolate content of <25 micro moll v/9% water and eruca acids <1% of fatty acids. Rapeseed must contain a maximum of 9% water at storage. At this percentage, it is a well-known fact that the seeds are not 100% dry for storage and that during storage slightly more free fatty acids (FFA) form.

*Which processes affect the by-product?*
During processing, focus is often primarily on the main product and on the efficiency of the product rather than on the by-product. Heat-treatment, the addition of enzymes or acid, fermentation, etc. may all affect the feed value. The process itself as well as the substances included, for instance extraction agent, may constitute a risk to food safety. The by-product may also have been in contact with materials that give off substances that are undesirable in feed, for instance softeners such as phthalates from plastic materials. Therefor it is important to know if the by-product is treated, for instance heated, refined, preserved or detoxicated, to ensure that is suitable for feed.

*Rape*: There are three ways to extract oil from rapeseed: pressing, extraction with petrol or enzyme treatment. The residual product is heated and dried. Heat-treatment during production of rapeseed meal should be strong enough to deactivate myrosinases, but gentle enough to prevent significant thermal decomposition of glucosinolates. Thermically decomposed glucosinolates are in particular observed on the content of 4-hydroxyglucobrassicin, which is the glucosinolate that is most sensitive to heat. A low content of 4-hydroxyglucobrassicin in proportion to the normal content may indicate heat damage. The normal content of this glucosinolate is typically min. 15% of the total content of glucosinolates (*Pedersen,* 2010). Recommendations for maximum glucosinolate content:

- 1 mmole per kg feed for weaners
- 2 mmole per kg feed for finishers and sows

*Physical form and storage requirements*
The physical form of a by-product, shelf-life and requirement for storage are essential to where and how in the production of feed the by-product can be handled. Liquid or dry storage, shelf-life and requirements for grinding must be clarified. This is particularly relevant for liquid by-products. Storage before delivery and transport also constitute contamination risks. Important questions are to be asked: Is there a risk that the by-product was contaminated underway in the chain from producer to supplier? Is the haulier approved for transport of feed? What was the last product transported in the truck? Has the haulier cleaned the truck? Is there, for instance, a procedure for cleaning?
*Rape*: Rapeseed cake and rapeseed meal must be stored in a dry place and is easy to transport. Inadequate drying or storage may cause Ochratoxin A to develop in rape.

**Establishment of standard values**
When formulating a diet, it is important to know the content of the individual ingredients. For years, PRC has analysed various ingredients to obtain knowledge of the following parameters (*Svarrer et al.,* 2009; *Vils et al.,* 2010):

- Nutrient content and digestibility (including variances between batches).
- Content of substances inhibiting pigs' productivity, such as toxins.

Standard values, in particular for by-products and roughage, are often uncertain as a consequence of too few feed analyses and, at the same time, nutrient content may vary greatly from batch to batch. There are several ways to take this into account; careful mixing, formulating feed, for instance, 5% above the nutrient standards or conducting frequent and sufficient feed analyses.

Analyses of identical samples are sometimes made at different laboratories to check for possible changes over time, to quantify differences in levels between different labs, check standard deviations within labs and between labs, and thereby provide a basis for deciding which lab is better. Since May 2003, PRC has completed 3 rounds of these analyses. Approximately 40–50 kg pelleted feed is subdivided into samples of

approximately 300 grams, and, with different intervals, a sample of this is forwarded to Eurofins and Agro Lab, and to the laboratory of the Danish Plant Directorate.

**Feed trials**

Pig Research Centre offers a wide range of feeding trials to ensure impartial documentation when testing by-products or feed additives in a reliable, quick and cost-effective manner. Feeding trials are conducted at either Grønhøj (experimental station) or in one of a number of pig production farms (trial hosts) that Pig Research Centre is in contact with. All trial diets are produced at a commercial feed mill. Production of trial feed is normally supervised by an experienced representative from PRC to ensure correct inclusion of the products and to check that mixtures are labeled correctly. His primary task is to ensure that all procedures relating to the production of the feed are followed. He also coordinates the entire process until the feed is delivered at the experimental station/pig farm.

*Statistical analyses*

All feeding trials conducted by PRC are designed to have a statistical power of at least 80. Statistically significant differences are indicated at a five per cent level ($P<0.05$). Data is subjected to an analysis of variance, and levels of significance (P-values) are corrected for multiple comparisons in a Bonferroni t-test. The trials are designed to detect a difference in production value of 10%.

In all trials, the results achieved for the different parameters (feed intake, feed conversion ratio, daily gain, and, for finishers, lean meat percentage) are summarized into one value: a production value. This reduces the number of tests in the statistical analysis, thereby reducing the factor used in the Bonferroni adjustment of the obtained p-values. Furthermore, the overall economic effect of a product, i.e. the production value, is of greater interest to the pig producer than individual performance parameters. The statistical procedures and principles for data processing are established before a trial starts and are described, if required, in detail in the trial protocol.

*Equal performance trials*

Many products are expected to improve the performance of the pigs when added to a diet identical to the control diet. For some products, however, it may be more appropriate to formulate a negative control diet, add the product, and then compare performance against a positive control diet and a negative control diet. Thus, all equal performance trials must include a negative control treatment.

*Digestibility and balance trials*

In combination with a product trial in which production performance results are the primary parameters, it is also possible to conduct digestibility and/or balance trials. The same feed is used for production performance trials as for digestibility/balance trials. Production performance data can thus be compared with digestibility data and consequently provide further knowledge about the effect of a product. Digestibility and balance trials are arranged with the Faculty of Agricultural Sciences, Aarhus University.

*Trial facilities*

Trials are normally conducted at PRC's experimental station "Grønhøj". All work and management routines are generally identical to those of any other commercial farm. At Grønhøj, skilled staff is employed to help implement the trials and the facilities are fitted with additional equipment (silos, feeding systems, etc.). Whenever it is not possible for

PRC's experimental station to comply with special requirements related to the design of a trial, it will often be possible to recruit suitable commercial farms among the large number of trial hosts known to PRC.

*Trial protocol*
All trials are conducted in accordance with the guidelines stated in the trial protocol for each trial, which is prepared prior to the start of the trial. All feeding trials with finishers are conducted according to the same fundamental guidelines, but the number of animals, groups and replicates involved may vary from one trial to another (*Hansen,* 2011).

**Guiding inclusion rates**
Feeding trials form the basis of PRC's list of guiding inclusion rates. For each ingredient, a guiding maximum limit is determined for the recommended inclusion for pigs in different growth and production phases. These limits are not supported by trial evidence in all cases, but are instead based on scientific evaluations and practical experience. The *table 1* provides a few examples of guiding maximum limits.

**Table 1.**

**Guiding maximum inclusion in pig feed, % of kg feed**

| | Sows (1) | | Weaners (2) | | Finishers (3) | |
|---|---|---|---|---|---|---|
| | **Gestating (4)** | **Lactating (5)** | **From 3 wks (6)** | **From 5 wks (7)** | **Under 40 kg (8)** | **Over 40 kg (9)** |
| Soybean meal, toasted (10) | 30 | 30 | 10 | 20 | 30 | 30 |
| Sunflower meal (11) | 15 | 15 | 0 | 5 | 10 | 15 |
| Rapeseed cake & rapeseed meal (12) | 12 | 12 | 5 | 5 | 10 | 15 |
| Rapeseed (13) | 12 | 12 | 0 | 4 | 4 | 4 |

(*Jørgensen,* 2009)

*1. táblázat: Maximális javasolt bekeverési arány sertéstápokban, %*

*Kocák(1), Választott malacok(2), Hízósertések(3), Vemhesség alatt(4), Laktáció alatt(5), 3 hetes kortól(6), 5 hetes kortól(7), 40 kg alatt(8), 40 kg felett(9), Szójadara(10), Hő kezelt napraforgódara(11), Repcepogácsa és repcedara(12), Repcemag(13)*

Furthermore, results from a trial not yet published demonstrate that limits should be established for the content of sunflower combined with rape products: inclusion of a combination of 10% rapeseed cake and 10% sunflower meal significantly reduced the productivity (*Hansen,* 2011). It is recommended that the guiding maximum limits for inclusion of by-products be lowered by 25–50% if several by-products are used at the same time. This reduces the risk of decreasing productivity levels. The limits for inclusion of the individual ingredients should be lowered if several uniform feedstuffs are used in the same diet.

## CONCLUSIONS

Danish experiences with the use of by-products are based on detailed considerations prior to the use of by-products/new by-products. These considerations are particularly important if the ingredient is expected to vary greatly.

Many of the known feedstuffs are by-products from Denmark as well as from other countries. They are listed in feedstuff tables and described in the EU's index of feedstuffs. This index provides no information on the critical substances the individual feedstuffs may contain; ie. there is no guarantee that the product is safe. Many by-products are sold by the feedstuff companies with a guarantee of content as well as quality. In these cases, it is normally not necessary to consider the quality of the by-products before deciding to buy them and use them on the farm. With lesser known or new by-products, the above evaluation should be completed.

## REFERENCES

Hansen, S. (2011). Feeding trials. http://www.pigresearchcentre.dk/About%20us/Feeding%20trials.aspx

Hansen, S. (2011). Rapskage og solsikkeskrå til slagtesvin gav forringet produktivitet. Upubliceret. Videncenter for svineproduktion. http://vsp.lf.dk/Publikationer/Kilder/lu_medd/2011/914.aspx

Jørgensen, L. (2009). Råvarer – maks. indhold. http://vsp.lf.dk/Viden/Foder/Opslagstavlen/Raavarer_max%20indhold.aspx

Maribo, H. (2010). Smågrisefoder tilsat 15 % rapskage eller –skrå. Meddelelse nr. 890. Videncenter for svineproduktion og den rullende afprøvning. http://vsp.lf.dk/Publikationer/Kilder/lu_medd/2010/890.aspx?full=1

Pedersen, A.Ø. (2010). Skadelige stoffer. Videncenter for Svineproduktion. http://vsp.lf.dk/Viden/Foder/Foderkvalitet%20og%20fejl/Skadelige%20stoffer.aspx?full=1

Plantedirektoratet (2010). Biprodukter som foder – tag den rigtige beslutning. En guide til landmanden, pjece udgivet af Plantedirektoratet. http://issuu.com/foedevareministeriet/docs/biprodukter_som_foder

Sloth, N.M., Vils, E. (2010). Fodermiddeltabellen er ajourført, Notat 1019, Videncenter for Svineproduktion. http://vsp.lf.dk/Publikationer/Kilder/notater/2010/1019.aspx?full=1

Svarrer, R.I, Sloth, N.M., Vils, E. (2009). Næringsindhold i korn fra 2009, Erfaring 0910, Videncenter for Svineproduktion. http://vsp.lf.dk/Publikationer/Kilder/lu_erfa/2009/0910.aspx?full=1

Tybirk P., Strathe, A.B., Vils, E., Sloth, N.M., Boisen, S. (2004). Det danske Fodervurderingssystem til Svinefoder, Rapport nr. 30, Dansk Svineproduktion. http://arkiv.dansksvineproduktion.dk/.html?id=e388bc86-147c-4b7e-bd49-ebba098a4a54&templateuid=08004d2f-0f3b-47d9-a674-8785310e6190

Tybirk, Per (2010). Fodervurdering. http://vsp.lf.dk/Viden/Foder/Raavarer/Fodervurdering.aspx

Vils E., Sloth, N.M., Tybirk, P. (2005). Ny fodermiddeltabel til Svin. Notat nr. 0509, Dansk Svineproduktion. http://vsp.lf.dk/Publikationer/Kilder/notater/2005/0509.aspx?full=1

Vils, E., Svarrer, R.I. (2010). Analyse af foder, Videncenter for Svineproduktion. http://vsp.lf.dk/Viden/Foder/Foderkvalitet%20og%20fejl/Fejl%20ved%20raavarer%20og%20foder/Analyse_foder.aspx?full=1

Corresponding authors (*levelezési cím*):

**Rikke Ingeman Svarrer**
Project Manager, M.Sc. Agriculture
Pig Research Centre, Advisory Activities
Agro Food Park 15, 8200 Aarhus N., Denmark