Opportunities for Co-Product Utilization in Western Canada

Ruurd T. Zijlstra[1] and Eduardo Beltranena[1,2]

[1]Department of Agricultural, Food and Nutritional Sciences, University of Alberta, Edmonton, AB T6G 2P5; ***Email***: ruurd.zijlstra@ualberta.ca
[2]Alberta Agriculture, Food and Rural Development, #204 JG O'Donoghue Building, 7000 – 113 Street, Edmonton, AB T6H 5T6; ***Email***: eduardo.beltranena@gov.ab.ca

■ Introduction

Crop fractionation is the separation of grain stock into two or more fractions. Historically, fractionation of western Canadian crops has been conducted by placing the entire grain stock into a process, resulting in the production of a main fraction, and one or more co-products, also known as by-products. The production of canola oil and canola meal from canola seed, ethanol and wheat distiller's grain plus solubles (DDGS) from wheat, flour and wheat millrun from wheat, and beer and brewer's grain from barley are such examples. Traditionally, the fractionation of crops has resulted in a higher net income to the crop producer than merely production of crops for feed purposes. As a benefit of fractionation, co-products have become available for inclusion in feeds. The use of co-products has been adopted globally at a large scale. In western Canada, the use of co-products in feeds has been adopted reluctantly because grains could be included in feeds competitively. However, this scenario is changing rapidly with the emergence of increased fractionation capacity in western Canada driven by bio-fuel production. As a result, feed grains will become relatively more expensive, and the inclusion of existing or new co-products in feed is becoming an economic necessity to remain competitive.

Overall, the markets of swine feed can be divided into two categories:

- the large volume, low margin diet market such as for grower-finisher pigs and
- the low volume, higher margin diet market such as for weaned pigs.

For each category, specific sets of co-products will be used. The first category will focus more on the traditional market of co-(or by-) products from food or bio-processing. The second category will become an attractive market for the specific fractions created for feed purposes. This paper summarizes this vision and recent findings.

Competition for Energy

The growing interest for a local biofuel industry means that increasing economic pressure will be created for starch and oil from crops. The starch is being targeted for ethanol production and the oil for biodiesel production. The predominant grain stocks are locally produced wheat and canola, respectively. The use of these crops for the biofuels industry implies that increasing amount of wheat DDGS and canola meal will become competitively available as feedstuffs. Crop producers will continue push the limits to maximize canola acreage and yield, and as a result, production of less competitive feed grains will proportionally decline. Feed grains may become, to some extent, a crop strictly used to maintain a crop rotation.

The inclusion of co-products in feed will rapidly become economically attractive as the severity of grain shortage become evident. Initially, co-products will become attractive on a cost per tonne basis; their low inclusion rates should not hamper growth performance. Later on, when economics focus shifts more to cost per unit of productivity and less to maximization of growth performance, inclusion rates of these co-products might further increase. Starch fermentation and oil extraction results in these co-products being high in fibre and protein. In this session, results of recent research using wheat DDGS (Widyaratne and Zijlstra 2007) and wheat millrun (Nortey et al. 2006) will be shown. Overall, these studies indicate that these co-products still provide valuable nutrients for swine, but also that their nutrient digestibility is reduced by fibre content.

The increased competition for bio-energy and the use of co-products that are rich in fibre and protein, also suggests that evaluation systems for feed energy need increased attention. In Western Europe, and in particular in The Netherlands, the increased use of co-products was supported by a shift to the net energy (NE) system, which considers the energy content of the individual macronutrients. As a result, high fibre and(or) high protein co-products will have a relative lower NE value compared to high starch or high oil feedstuffs. Some of the negative effects on growth performance related to the increasing using of co-products in diets formulated based on digestible energy (DE) content can thereby be avoided.

▪ Value-Added Processing

A range of processing techniques can be employed to fractionate crops. Overall, two groups exist:

- Group 1 - an up-front fractionation process allowing further processing of individual crop fractions
- Group 2 - a process that involves the entire crop stock that separates one fraction the crop (as described before).

Examples of group 1 include dry milling and air classification, etc. Examples of group 2 include current ethanol production procedures and oil extraction from canola. Dry separation techniques (dry milling/air classification) are particularly useful for the production of protein-rich fractions from non-oilseed legumes, such as field pea (Dijkstra et al. 2003). The advantages of dry over wet separation techniques are lower equipment and operational costs and the absence of effluents. However wet processing techniques usually result in fraction containing a higher protein or starch concentration. Group 1 and 2 processes can be combined for one ingredient. For example, oil is first extracted from soybean, resulting in soy oil and soybean meal. Subsequently, soybean meal is fractionated into several protein fractions including protein concentrates and isolates, and even more purified fraction, such as isoflavones (Potter 1998).

▪ Examples of Value-Added Processing

Below are some examples of value-added processing of western Canadian crops. Most of these crops have a primary market in the food or bio-processing industries.

Canola is the premier success story in western Canadian agriculture and is the current main cash crop. At the crusher, canola seed is processed into canola oil and canola meal using solvent extraction. The refined oil is mostly targeted towards human consumption, but both the crude or partially-refined oil and meal fractions are used in animal agriculture. The oil can also be converted into biodiesel or bioplastics. Limitations for the optimum feed use of canola meal remain its compounds NSP, phytate and others that limit nutrient digestibility. Further diversification for canola has been achieved by wet fractionating the meal into a variety of fractions for feed purposes by MCN Bioproducts Inc (Saskatoon, SK).

Flax fractionation is receiving increasing attention recently. The use of flax oil for human health benefits was started centuries ago. However, the use of flax for health or other performance benefits has not been adopted by the commercial swine industry on a large scale. The flax fractions oil and hulls appear to enhance beneficial intestinal microbial profiles (Smith et al. 2004). The use of processed flax to increase the omega-3 fatty acid content of pork has been adopted commercially by Prairie Orchard Farms (Winnipeg, MB).

Oat fractionation has been commercially adopted, but is largely limited to the swine industry to simply de-hulling. The largely non-digestible hull must be removed, but the resulting oat groat has become a main-stay ingredient. Oat groats contain 7% oil, are highly digestible, and appear to enhance diet palatability. Oat groats are therefore included in starter diets.

Barley fractionation on the Prairies is mainly directed to malting and brewing. Similar to oats, most of the barley fibre is contained in the barley hull. The hull content is less in barley than in oats. The fibre contained in barley hulls also appears to be more fermentable than that in oat hulls. Still, barley fibre is negatively related to energy digestibility in pigs. Removal of barley hulls is conducted via processing or by growing a natural variant, hull-less barley. The acreage of hull-less barley has declined, largely because the crop could not compete with wheat in the feed market. Furthermore, the hulls of hull-less barley remains on the field, and the value enclosed in the hull fibre can thus not be captured. Recently, the functional properties in barley fibre have been explored. The β-glucans have been extracted from barley using wet fractionation, and the remaining starch-rich fraction may find applications in the food and feed industries. (Johnson et al. 2006).

Wheat has been used historically for baking flour production. Wheat co-products from dry milling have been used in the swine industry, but the potential has not yet been reached (Nortey et al. 2006). Wheat has the highest starch content among the main feed commodities in western Canada. As such, wheat is the main feedstock for ethanol production in Saskatchewan and Manitoba. The DDGS co-product has been used mostly as a feedstuff for cattle. Logistics, and in particular transportation costs, may also increase the use of wheat DDGS by the swine industry, similar to corn DDGS. Wheat DDGS appears to be higher in crude protein than corn DDGS. However, part of this extra crude protein is simply damaged protein degraded to non-protein nitrogen (Widyaratne and Zijlstra 2007). Feeding of high levels of grain DDGS may reduce voluntary feed intake, and thereby growth performance.

Field pea is an interesting crop for ingredient fractionation, because it contains a reasonable starch and protein content and low fibre. Locally, field pea has been fractionated commercially at Parrheim Foods (Saskatoon, SK). Pea starch is less digestible than cereal starches by the end of the ileum, and rate of starch digestion of peas appears to be lower. Pea starch thus has a lower glycemic index than wheat or barley starch.

The feed use of value-added fractions further implies that not just the digestible nutrient content of these fractions should be described. Their functional properties relative to animal health, welfare, nutrient management, and pork quality must be considered but such benefits are not so tangible. Consideration of such benefits will ensure that their entire value and potential within commercial swine production can be reached.

Conclusions

The rapid advancement of crop fractionation and the proliferation of processing facilities across North America will continue to drastically change the landscape for feedstuffs. In western Canada, the removal of transport subsidies provided a window of opportunity for the use of relatively abundant and affordable feed grains in the livestock industries. The emergence of the bio-fuel industry will place increasing pressure on the price and availability of feed grains, but should reduce the price pressure of protein-rich co-products. As a result, the use of these co-products is becoming rapidly more attractive. These co-products seem to fit now more often in the large volume low margin markets of grower-finisher pig feeds. Pork producers will have to explore these opportunities rapidly to remain competitive in the North America. The high-value crop fractions seem to fit the requirements of weaned pigs and in instances where specific functional attributes may enhance animal health, welfare, nutrient management or pork quality.

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