Quality and Value of Cruciferous Oilseed Crops

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The title of The 11th International Rapeseed Congress, July 2003, Copenhagen, Denmark was “Towards enhanced value of cruciferous oilseed crops by optimal production and use of the high quality seed components”. Attempts to digest and evaluate the huge number of contributions presented at this congress, and described in the proceeding accompanying the congress [ISBN 87-7611-004-4], give basis for considerations about “the stat of the art” and “future opportunities for cruciferous oilseed crops and products produced from them”.

The professional and international broad composed group of participants (ca. 700), researcher and other contributors has covered the various areas related to cruciferous oilseed crops. This is subjects from development of appropriate seed materials, through production of seeds under different conditions, storage, processing and end uses of the products in feed, food and non-food applications. World wide, *Brassica napus* oilseed rape is the quantitatively dominating cruciferous oilseed crop. However, other Brassica species of the U-triangle and some few of other crucifers call as well for attention with respect to production of valuable products.

Consideration of the chemical composition of the seed dry matter (DM) in cruciferous oilseeds show that the main constituents are oil/lipids (40-48 % of DM), proteins (15-25 % of DM), and dietary fibers (DF) or non-starch carbohydrates (15-28 % of DM). These main constituents are followed by a complex group of minor constituents, which mainly are low molecular weight (LMW) compounds (10 ± 5 % of DM), and they are often decisive factors for the quality of cruciferous products.

The quality and value of the oil/lipids are clearly an important factor determining the value of the seeds. However, the value of cruciferous seed depends also of the quality and value of the other seed components, especially the proteins, DF and some very important minor seed constituents. These minor seed constituents comprise oxidative sensitive compounds and especially glucosinolates derived products, which give crucifer products typical and characteristic properties. Depending on the concentration of individual or structural different types of these LMW compounds, as well as the target for application of the cruciferous seed or products derived from these, the resulting effects of these compounds can be strongly negative, neutral or positive. This means that the type of seed material, storage, and especially processing conditions are key parameters, which need to be considered in relation to end product applications. All steps from starting material to end product applications have to be controlled by appropriate analytical methods when the final goals are high quality and thereby enhanced or high value products.

The knowledge to production of cruciferous oilseed crops, their important constituents, methods and technologies are now available, as seen from presentations at the above mentioned 11th International Rapeseed Congress. Thereby, cruciferous oilseed crops have the potential to give the wanted and mandatory progress with respect to quality and enhanced value of end

products. This requires appropriate selection of starting materials, seeds, methods and technologies for processing and analytical documentation of the product quality.

Cruciferous oilseed crops

Important information on quality and value of cruciferous oilseed crops are included in the contributions form the approximately 700 participants at the 11th International Rapeseed Congress, published in more than 500 papers included in the proceedings and abstract books. These contributions are dominated by investigations performed with *Brassica napus* oilseed crops. Opportunities for new corps based on the other members of the U-triangle (*B. juncea, B. carinata, B. rapa (campestris), B. oleracea and B. nigra*) as well as *Sinapis alba, Eruca sativa, Crambe abyssinica* and some few other crucifers have also been evaluated in contributions from the plant breeding and agronomic sectors. These two sectors were the quantitatively dominating contributors to papers in the proceedings. A great part of these contributions were devoted to plant pest problems, disease resistance, biotic and abiotic stress, crop husbandry, seed yield and quality. Growth place and conditions are decisive factors for the relevance and opportunities for growing of different cruciferous oilseed crops with acceptable yields. The quality and thereby value of the seed and products obtainable from this define, however, the end uses (vide infra) and thereby the economic profit and interest these crops have for producers, agro-industries and the end users.

The opportunities and acceptance of GM crops are hot subjects where no final agreement has been found, and several problems have still to be solved in this connection. Bio-fumigation based on use of different cruciferous crops is an other relatively new area, which has attracted some interest. However, much more work needs to be done before conclusions can be drawn on the possible value and interest for use of bio-fumigation.

Feed, food and non-food uses of cruciferous oilseeds

Cruciferous oilseeds as *B. napus* oilseed crops have a chemical composition of seed dry matter composed by various major and minor components as mentioned in Table 1.

Table 1. Chemical composition (% of DM) of major and minor components of double low oilseed rape.

Lipids	Triacylglycerols (TAG's)/oils (40-48 % of DM) and minor lipophilic and amphiphilic compounds as phospho- and glycolipids, fat soluble vitamins, tocopherols, carotenoids, phytosterols, phenolics/antioxidants, chlorophylls
Proteins	(15-25 % of DM), cruciferins, albumins, enzymes (myrosinases, lipases, lipoxygenases, aromatic choline esterase), napins, oleosins, and peptides
Carbohydrates	Dietary fibers (DF)/non-starch carbohydrates (15-28 % of DM), oligosaccharides and various glycosides
Minor constituents	(10 ± 5 % of DM), lipid types (see above) glucosinolates and glucosinolate derived products, phenolics, sinapine and other sinapoyl derivatives, non-protein amino acids

The two main constituents in seeds of *B. napus* double low oilseed rape, the rapeseed oils and the proteins are in their native forms of high nutritional value (B.O.P. project, 2000). With appropriate processing conditions, the high quality oils (TAG's) and proteins are conserved in processed products (Bjergegaard et al., 1996, Bagger et al., 1998; B.O.P. project, 2000), as revealed from use of the products to monogastric animals. To avoid negative effects on monogastric animals from rapeseed glucosinolates present in the feed, it is necessary to have a level below 2 µmole/g feed DM and to avoid glucosinolate degradation during processing. (Bjerg et al., 1987). This means that we need to have a glucosinolate level in the seed DM of double low B. napus oilseed rape below 10 µmole/g DM if rapeseed meal corresponding to 20 % rapeseed is included in the diets. These recommendations are also in agreement with results published by various groups in the section on feed in vol. 4 of the proceedings from 11th International Rapeseed Congress. However, the majority of European grown double low rapeseed cultivars have a much higher level, which can give serious problems especially for young monogastric animals, (Bjerg et al., 1987; B.O.P. project, 2000).

To produce protein isolates for food applications, it is furthermore important to avoid the color from oxidation products of 4-hydroxyglucobrassicin (Jensen et al., 1991; Napus project 2004). This provide demands for new and gentle bio-processing technologies, which have been developed as basis for productions of high quality and high value rapeseed oil as well as protein isolates with its native antioxidants, when or if the products are wanted as high quality food and for uses in various non-food products (Bagger et al., 1998; B.O.P. project, 2000; Vol. 2 of 11th International Rapeseed Congress, 2003; ENHANCE project, 2003; Napus project, 2004).

The new bio-processing technologies comprising cold pressing of dehulled double low *B. napus* rapeseed, and supercritical fluid technologies provide the foundation for high quality rapeseed oils with its content of the native antioxidants. This oil has been shown to have a high nutritive value, with a well balanced ratio between ω-3 and ω-6 fatty acids (FA). The aqueous based separations used in connection with productions of protein concentrates and isolates result as well in fractions with glucosinolates together with various types of minor seed components (Table 1). The new bio-processing technologies (Bagger et al., 1998, Palmieri et al., 1998, B.O.P. project 2000, Sørensen et al, 2001, Proceedings of 11th International Rapeseed Congress 2003, Vol.2), have much higher processing cost than traditional oil mill processing, and it give the basis for much higher product values. The two types of processing technologies are, thus, complementary and they do not give competitions on the same type of end user markets. The new types of markets for bio-ethanol production from e.g. non-starch polysaccharides and bio-diesel are low value products where the cheap and traditional oil mill technologies have to be used. The interest, presentation, discussions and focus on opportunities for production of bio-diesel from rapeseed oil, were very attractive for many of the participants at the 11th International Rapeseed Congress.

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