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Biochemical characterization of industrially produced rapeseed meal as a protein source in food industry

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Abstract

Rapeseed meal is a by-product of oil production which is primarily used in feed industry. The application of the rapeseed meal as a protein source in food industry is an alternative which leads to a better and more complete use of this by-product. Biochemical characteristics of industrially produced rapeseed meal vary and therefore, detailed analyses prior to its use as a protein source is necessary. The commercial rapeseed meal evaluated in this study contained high protein amount (39.86 %) and low residual total fats (2.30 %). It was characterized with low levels of glucosinolates (12.69 ± 0.18 μmol/g) and phenols (1.13 ± 0.04%). Amino acid analysis revealed lysine as the first limiting amino acid with an amino acid score of 58.00%, followed by valine (66.86%). However, this by-product was rich in leucine and isoleucine which amino acid scores equaled to 97.60 and 88.67% respectively. The amino acid score evaluation demonstrated relatively high amount of sulphur containing amino acids (82.57%). The commercial rapeseed meal exhibited low *in vitro* digestibility (18.59 ± 0.98%). The albumin, globulin and glutelin fractions however, expressed higher digestibility with albumin fraction being the most susceptible (67.22 ± 1.28%) to pepsin and pancreatin proteolytic activities.

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Keywords: rapeseed meal; biochemical characterization; digestibility.

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1. Introduction

Rapeseed is a major oil-bearing crop. From 1992 to 2012, the worldwide production of rapeseeds exceeded the one of the cottonseeds thus turning it to the second most important world's oilseed plant after soybean (Carré and Pouzet, 2014). During that period of time, China, India, Canada and European Union (27) contributed the most to the expansion of the rapeseed production. In Bulgaria, rapeseed is the second most cultivated oil-bearing crop after sunflower. In 2014, the surface area sown with rapeseed reached 191 572 ha, while seed production equaled 527 912 tons (Ministry of Agriculture and Food, Republic of Bulgaria, 2015). After the enhancement of rapeseed oil utilization as a feedstock for biodiesel generation, the worldwide production of rapeseeds has been predicted to increase (Carré and Pouzet, 2014).

Due to the high oil content (42%), rapeseeds are mainly used for oil production. They also contain relatively high amount of proteins (22-24%) which may increase up to 40% after oil extraction. The remaining product, known as rapeseed meal, represents approximately 48% of the total quantity of the rapeseeds used for oil production (Ivanova, 2012). Rapeseed meal is characterized with a relatively balanced amino acid composition with an except for lysine which makes it appropriate as a protein-rich additive in feed industry (Newkirk, 2009). However, its application as a feed ingredient is limited by the presence of anti-nutrients and high fiber content which impact protein digestibility and overall animal metabolisms. As a result, a considerable amount of the annual rapeseed meal remains unutilized thus converting into a rather waste product.

Other than utilized for feed supplementation, the rapeseed meal has the potential to serve as an alternative plant protein source for human consumption (Tan et al., 2011). However, the quality of rapeseed meal is highly variable and is dependent on various factors (Bell and Jeffers, 1976; Li et al., 2015). The type of rapeseed cultivar, environmental conditions during growth as well as soil type and composition affect the quality of the seeds which in turn, determines the quality characteristics of manufactured products (Bellostas Muguerza et al., 2007). Some alterations in rapeseeds properties during storage may also occur. The industrial procedure of oil extraction used as well as the seed pre-treatment may exert variations in anti-nutrient concentrations, protein digestibility and amino acid composition of rapeseed meal (Newkirk and Classen, 2002; Ayton, 2014). Therefore, a biochemical characterization of industrially produced rapeseed meal prior to its application as a protein source in food industry is necessary. Furthermore, while published data obtained on rapeseed meal produced and analyzed under laboratory conditions are abundant, studies performed on industrially produced rapeseed meal are scarce. The goal of the current study was to establish the biochemical characteristics of rapeseed meal, industrially produced in Bulgaria. The amino acid composition as well as in vitro rapeseed meal protein digestibility was also evaluated.

2. Material and Methods

2.1. Material

Rapeseed meal was provided by a local company. It was produced after thermal treatment of rapeseeds at 110-115ºC and oil extraction with hexane at 60-65ºC. The industrially produced rapeseed meal was additionally grinded and sifted to collect 0.315 mm particles which were used for analyses. All reagents used were of analytical grade.

2.2. *Biochemical characterization of rapeseed meal*

Total nitrogen was determined by Kjeldal's method and multiplied by 6.25 to convert to crude protein (Tomov et al., 2009). Biuret method (AACC, 1983) was used to evaluate protein content in extracts whenever it was needed. Bovine serum albumin was used for standard curve generation. Crude fat content of the rapeseed meal was determined by Soxhlet extraction method (ISO 7302:2003). Fiber and ash contents were determined by ICC Standard №156 and ICC Standard №104/1 respectively. Total phenols were extracted as describe by Villanueva et al. (1999) and quantified by using Folin-Ciocalteu reagent (Ainsworth and Gillespie, 2007). Total glucosinolates were evaluated as described by Jezek et al. (1999). The method is based on spectrophotometric evaluation of glucosinolates after alkaline hydrolysis and reduction with potassium ferricyanide. Sinigrin was used for standard curve generation.