Effect of long-term feeding of black and yellow types of full-fat rapeseed on growth and reproduction of rats

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Introduction

Full-fat double low rapeseed (FFRS) is an excellent source of protein and energy in ration for monogastric animals. In addition, being also a good source of n-3 fatty acids it influences on the quality of animal products, enriching them with n-3 fatty acids, which might have beneficial effects on human health. It has been commonly believed that the use of double low rapeseed or its meal for feeding purposes is limited due to high level of dietary fibre. It was also suggested that introducing triple low rapeseed with noticeably decreased content of dietary fibre with yellow colour of seeds should overcome this problem.

The aim of the study was to investigate whether newly developed yellow-seeded lines of winter oilseed rape have some advantage over black-seeded counterpart on growth performance, reproduction and lactation and organ developments in rats as evaluated by long-term feeding experiment.

Materials and Methods

Material for this study comprised of two batches of blended seeds of different yellow-seeded lines and seeds of standard Kana cultivar. Commercial available spring wheat (Jasna cultivar) and rapeseed samples were chemically analyzed for protein, fat and dietary fibre in agreement with the AOAC and AACC methods. The seeds were heated for 5 minutes in boiling water bath, dried and then crushed together with finely ground wheat before mixing with rest of diet ingredients. Three diets, with the same levels of protein (20%) and metabolizable energy 15.7 MJ/kg were formulated, which consisted of 30% full-fat rapeseeds and 55% wheat. Twenty four Wistar albino rats (12 males and 12 females) were selected and divided into three experimental groups of four males and four females of exactly the same lineage. Exposure to experimental diets started at rat age of 5-6 weeks and lasted through growth period of parental generation, mating, pregnancy, lactation and finished when first generation of rats reached, on average, about 170 g of live weight. The rats were pairing at the age of 10 weeks for 14 days. Pups counted at birth and weighted at three days, at which time the size of each litter was reduced to 8 rats, with the same number of both genders. After ending the particular periods of development the rats were sacrificed and internal organs, like liver, spleen, kidney and thyroids were immediately taken together with femur bone and weighted and then their relative weights calculated. Ash content was determined in femur. The animals were fed experimental diets *at libitum* and had free access to water. Rats were individually weighted twice a week, while diet intake was noted weekly per each pen. Data collected were divided into parental and first generation data and submitted to statistics according to SAS.

Results

The rapeseed samples had similar contents of protein, lipids and nonstarch polysaccharides (Table 1). The results clearly demonstrate and confirm our study with selected best yellow lines that the highest difference in chemical composition between yellow and black-seeded rapeseeds is associated with lignin content.

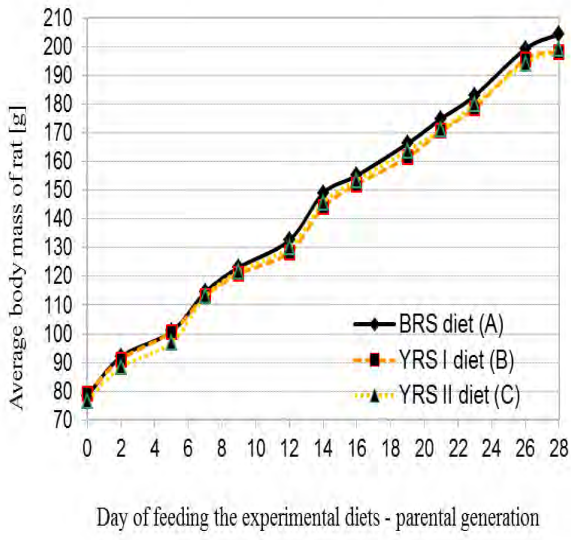
The type of full-fat rapeseeds used did not have any impact ($P>0.05$) on growth and development parameters of rats fed the experimental diets (Figure 1). The weight of internal organs, such as liver, kidney and spleen and also weight of thyroid glands were very much the same between three groups of rats. Moreover, we did not observe any differences in the degree of bone mineralization between rats as average content of ash in femur of rats fed yellow or black-seeded full-fat rapeseeds was practically the same, 61-62%.

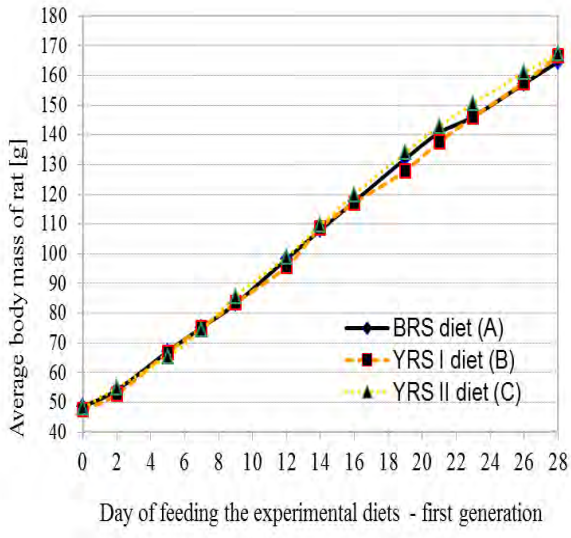
Table 1. ***Chemical composition of wheat and full fat rapeseed samples used in experimental diets (g/kg DM)***

Item	Wheat	Black rapeseed	Yellow rapeseed A	Yellow rapeseed B
Protein	145	237	232	215
Total lipids	27	462	468	525
Water-soluble NSP	37	48	29	41
Water-insoluble NSP	68	67	83	83
Total NSP	105	115	112	124
arabinose*	27 (6)	51 (16)	49 (9)	58 (15)
xylose	46 (10)	21 (7)	25 (6)	28 (5)
mannose	3 (1)	4 (2)	5 (2)	4 (2)
galactose	3 (1)	21 (7)	23 (7)	22 (6)
glucose	38 (22)	31 (22)	22 (9)	26 (17)
Klason lignin	29	135	76	52

* in the parentheses shown the amount of soluble sugars

Figure1. ***Growth curves of paternal and first generations of rats fed diets containing either black-seeded (BRS), or two different blends of yellow-seeded (YSR I and YSR II) full-fat rapeseeds.***





Reproductive and lactation parameters, size and weight of individual pups at birth and weaning, fed two types of rapeseed were also comparable (Table 2).

Table 2. ***Development performance parameters during mating, pregnancy, parturition and lactation periods of rats fed black-seeded or yellow-seeded full-fat rapeseeds [g]***

Item	Wheat-black rapeseed diet A	Wheat-yellow rapeseed I diet B	Wheat-yellow rapeseed II diet C
Body wt. of males at coupling	235 ± 6	222 ± 9	231 ± 30
Body wt. of females at coupling	174 ± 15	175 ± 5	167 ± 3
Body wt. of females at mating	184 ± 14	182 ± 4	198 ± 28
Body wt. gains of females at pregnancy			
– week I	24.1	27.0	20.8
– week II	27.6	31.3	28.8
– week III	45.6	51.6	47.0
Total wt. gains of females at pregnancy	97.3 ± 11	109.9 ± 13	96.6 ± 13
No. rats per litter	11.5 ± 1.9	12.8 ± 2.1	11.0 ± 4.3
Wt. at 3 day of life:			
– litter	65.0 ± 9	70.9 ± 10	62.2 ± 23
– rat	5.7 ± 15	5.6 ± 0.4	5.7 ± 0.4
Wt. at 28 day per rat	48.5 ± 7	47.6 ± 4	48.3 ± 5

Table 3. ***Relative weights of some internal organs and ash content in femur of rats fed black-seeded or yellow-seeded full-fat rapeseeds***

Item	Wheat-black rapeseed diet A	Wheat-yellow rapeseed I diet B	Wheat-yellow rapeseed II diet C
Males body wt.	329 ± 9	342 ± 18	352 ± 10
Females body wt.	232 ± 13	239 ± 14	233 ± 9
Average body wt.	280 ± 52	290 ± 57	292 ± 64
Mass of organ:			
Thyroids, mg/100g body wt.	4.7 ± 0.5	5.2 ± 0.7	5.0 ± 0.6
Spleen, mg/100g body wt.	232 ± 39	215 ± 28	245 ± 39
Kidney, mg/100g body wt.	626 ± 36	651 ± 46	638 ± 40
Liver, g/100g body wt.	4.1 ± 0.7	4.6 ± 0.8	4.4 ± 0.7
Ash in femur, %	62 ± 1.9	61 ± 3.3	62 ± 2.5

The results of this study showed that yellow-seeded rapeseeds with substantially decreased level of dietary fibre, more precisely lignin, did not solve the problem of its poor nutritive value for simple-stomached animals. Their nutritive value is still very similar to that of traditional double improved rapeseed. This finding clearly demonstrates that further breeding works should be undertaken to improve nutritive value of rapeseed or its meal for monogastrics. Sinapine as phenolic compounds can form complexes with rapeseed proteins, also interact with enzymes, which may lower their nutritional availability. Developing low-sinapine rapeseed genotypes might be an alternative in reaching this goal. Such breeding efforts have already been initiated (Velasco and Möllers, 1998; Wolfram et al., 2010). Major genes of sinapine metabolism are identified and method, using a NIRS calibration, is developed to enable breeders to routinely screen breeding materials with respect to sinapine.

References

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