INFLUENCE OF APPLIED HEAT TRETAMENTS ON CHEMICAL COMPOSITION OF FLAXSEED INTENDED FOR BROILERS NUTRITON

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Abstract: *Extrusion and micronisation are one of the most frequent heat treatments used for enriching nutritive quality of feed in Serbia. Aim of this study was to investigate effects of those heat treatments on basic chemical composition, crude protein solubility index (PDI) and urease activity in flaxseed. Flaxseed was extruded in an "Oprema-zootehnička oprema", type M2, model 1000 extruder at 125±1 °C and microwaved in a microwave oven SAMSUNG GE82N-B with LED display at 450°C for 3, and 5 minutes. Application of extrusion led to statistically significant (P<0.01) urease activity reduction by 66.67%. Crude protein solubility index was 14.72% what is statistically significant (P<0.01) higher, compared to other experimental treatments. Based on the gained results it can be concluded that dry extrusion can be a good choice for thermal treatment of flaxseed intended for usage in broilers chicken nutrition.*

Key words**:** *flaxseed, extrusion, microwave roasting, nutrition, broilers*

INTRODUCTION

Flaxseed (Linum usitatissiumum L.) also known as linseed, is thought to be one of the world's oldest cultivated crops with evidence of cultivation dating back thousands of years. The crop is prized for its protein and oil content. The by-product remaining after oil extraction – flaxseed meal or linseed meal – is a source of protein used in animal nutrition. The seed is also used in animal production for its medicinal properties, in particular for its functions as a laxative as well as for improving skin and hair quality. Recently there has been a renewed interest in using flaxseed and flax oil in animal diets as it can be used to alter the fatty acid composition of egg and meat products and, therefore, provide functional health benefits for the consumer (Puvača et al., 2012a). Flaxseed has been consumed for centuries for its good flavor and for its nutritional properties. In recent years, as people have become more concerned about health, demand for flax in food and beverages, functional foods and dietary supplements has risen dramatically (Vukelić et al., 2012). Flaxseed oil has a very healthy fatty acid profile, with low levels (approximately 9%) of saturated fat, moderate levels (18%) of monounsaturated fat and high concentrations (73%) of polyunsaturated fatty acids (PUFAs). The PUFA content comprises about 16% omega-6 fatty acids, primarily as linoleic acid (LA), and 57% alpha-linolenic acid (ALA C18:3n-3), an omega-3 fatty acid. Flaxseed is a rich source of protein and energy; however, the seed does contain some unique antinutritional components that need to be considered before inclusion of this feed in animal diet. Inclusion of flaxseed in animal diet, especially for chicken is very often accompanied with depressed growth, when it is used in amount higher than 5 or 10%. The presence of antinutritional factors and the physical structure are the main limiting factors. Cyanogenic glycosides, linatine, soluble nonstarch polysaccharides, trypsin inhibitor and urease are the main antinutritional factors in row flaxseed (Shen et al., 2005). Cyanogenic glycosides contain a cyanide group. Row flaxseed has these glycosides stored in the vacuole, but, if the plant is attacked, they are released and become activated by enzymes in the cytoplasm. These remove the sugar part of the molecule and release toxic hydrogen cyanide which is very toxic for the animals in small amount. Storing them in inactive forms in the cytoplasm prevents them from damaging the plant under normal conditions (Ivanov et al., 2012). One of the most important antinutritive factors present in the raw flaxseed is trypsin inhibitor, which inhibits the effect of pancreatic proteases. Antinutritive thermo labile factors present in the flaxseed, including urease and trypsin inhibitors can induce growth inhibition, reduce feed efficiency utilization, goitrogens response, pancreas hypertrophy, hypoglycemia and liver damages of broiler chickens (Beuković et al., 2010). Processing of seed improves nutrient utilization and can potentially reduce the negative impact of antinutritional components. Heat treatments like extrusion and microwave roasting, which are mutually different in their usage, types of heat source, construction of the equipment and applied parameters of the process, surely is one of the most significant alternatives for feed processing, which with its high nutritive values can satisfy high demands of modern nutrition (Puvača et al., 2012b; Puvača et al., 2012c; Puvača and Stanaćev, 2012).

The aim of this study was to examine the effect of heat treatments such as extrusion and microwave roasting on chemical composition and reduction of urease activity in flaxseed, intended for usage in broiler chicken diets.

MATERIAL AND METHODS

Experimental work considering chemical analyses and microwave roasting of samples was conducted at chemical laboratory for feed quality control at University of Novi Sad, Faculty of Agriculture at Department of Animal Science, while the extrusion process was conducted at Institute of Food Technology in Novi Sad. Experimental plan with flaxseed is given in Table 1.

Table1

Experimental plan with the flaxseed

Sample	Heat treatment			
	No treatment	Extrusion	Microwave roasting	Microwave roasting
Flaxseed	Row flax	125°C, 10 sec.	450°C, 3 min.	450°C, 5 min.

Samples of flaxseed cultivated in Vojvodina, Serbia in 2012 were used for the experiments. All treatments were done on flaxseed from the same producer and same batch. Samples were ground on hammer mill to pass 1 mm sieve and stored in dark at room temperature, after which chemical analysis were performed. Row flaxseed was used for extrusion. Flaxseed was extruded in an "Oprema-zootehnička oprema", type M2, model 1000 extruder (Ludberg, Croatia). Capacity of this extruder is 850-1000 kg/h extruded feed. Nominal power of electric motor is 75 kW, and of screw feeder with engine 1.5 kW. Working temperature measured in the head of extruder during extrusion of flaxseed was 125±1 °C, extruder capacity was 90%, current strength 85-90 A, and jet diameter 8 mm. Microwave oven SAMSUNG GE82N-B with LED display was used for thermal treatment of flaxseed samples. Each sample was put in a thin layer on glass plate with diameter of 15 cm, uniformly distributed and placed into the microwave oven. Operating frequency of microwave oven was 2450 MHz, and working power was 450W. Samples were treated for 3, and 5 minutes for that working power. For analyzing variations (analysis of variance – ANOVA) and Tukey's HSD post-hoc test for comparison of means of samples treated with the extrusion and microwaves of the same power, but for different time of heating was used STATISTICA SOFTWARE VERSION 10 (Statsoft, Tulsa, OK, USA).

RESULTS AND DISCUSSIONS

Examinations of basic chemical composition and crude protein solubility index of row and heat treated flaxseed is given in Table 2, while the obtained results of urease activity levels of flaxseed before and after microwave and extrusion treatments are given in Table 3.

Table 2

Chemical composition of row and heat treated flaxseed

	Row flaxseed		**Extruded flaxseed**		**Microwaved flaxseed – 3min, 450◦C**		**Microwaved flaxseed – 5min, 450◦C**	
	χ	SD	χ	SD	χ	SD	χ	SD
Moister, %	5.82	0.06	5.93	0.03	3.31	0.01	1.71	0.01
Crude protein, %	23.26	0.49	23.69	0.21	23.57	0.39	23.99	0.07
Crude fat, %	39.52	0.34	38.82	0.41	39.22	0.20	38.42	0.23
Crude fiber, %	10.09	0.13	9.93	0.31	10.80	0.39	10.50	0.24
Ash, %	3.49	0.17	3.44	0.27	3.75	0.15	3.69	0.29
Ca, %	0.26	0.01	0.27	0.02	0.29	0.01	0.28	0.01
P, %	0.52	0.01	0.55	0.01	0.55	0.01	0.61	0.01
PDI, %	27.06[a]	0.03	14.72[b]	0.29	12.19[c]	0.22	9.24[d]	0.15

Results are presented as mean ± SD, n = 5

a-b, different superscripts within the same column indicate significant differences (P ≤ 0.05)

Table 3

Flaxseed urease levels before and after heat treatments

	Row flaxseed		**Extruded flaxseed**		**Microwaved flaxseed – 3min, 450◦C**		**Microwaved flaxseed – 5min, 450◦C**	
	χ	SD	χ	SD	χ	SD	χ	SD
Urease activity, mgN/g/min	0.12[d]	0.01	0.04[a]	0.01	0.09[c]	0.01	0.07[b]	0.01
Index, %	100.00		33.33		75.00		58.33	

Results are presented as mean ± SD, n = 5

a-b, different superscripts within the same column indicate significant differences (P ≤ 0.05)

Gained results shows that the application of extrusion process led to high statistically significant (P<0.01) reduction of urease activity compared to untreated and microwave treated flaxseed. Reduction of urease activity of flaxseed roasted in duration of 5 minutes on 450◦C was statistically significant (P<0.05) higher compared to flaxseed roasted on 450◦C for 3 minutes. Reduction percentage of urease activity of applied heat treatments was 66.67; 25.00; and 41.67%, respectively. When it comes to crude protein solubility index (PDI), it can be noticed that extrusion process treatment had significant higher (P<0.01) values compared to the other experimental treatments. Recorded PDI values was 27.06; 14.72; 12.19; and 9.24% (P<0.01), respectively. Shen et al. (2005b) examined the effects of processing including pelleting, autoclaving, and microwave roasting on nutrient utilization in leghorn roosters. Pelleting the seed three times increased fatty acid retention by 29%. Microwaving for four minutes increased fatty acid utilization by 39% and autoclaving increased fat utilization by 20%, demonstrating the positive effects of heat treatment on flaxseed utilization. Nitrogen retention was also significantly improved by heat and physical processing. Feng et al. (2003)

concluded in their work that microwave roasting achieved the highest level of HCN reduction in linseed among autoclaving, pelleting and dry-heating in oven. They also showed that there were no major changes in the main nutrient and fatty acid profile caused by microwave treatment. Wu et al. (2008) investigated detoxification of linseed by extrusion. According to their results, extrusion can be considered a highly effective process in removing cyanogenic glycosides and trypsin inhibitors, but there was no data about comparison between extrusion and other processes. Similar results with extruded rapeseed grain gained Stanaćev et al. (2011) in their investigation. Ivanov et al. (2012) investigate effect of microwave heat treatment on the content of hydrogen cyanide, and consequently cyanogenic glycosides in flaxseed and came to conclusion that conditions of 400W of microwave power and 4 min 50 s of treatment were optimal for the reduction of HCN content under allowed limits. Shen et al. (2005a) fed broiler chickens 12% flax from 1-21 days and 15% from 22-40 days. Feeding whole flax reduced body weight, feed intake and feed efficiency but feeding flaxseed that had been previously pelleted and mashed significantly improved body weight gain, feed conversion efficiency and feed intake.

CONCLUSIONS

Based on the gained results it can be concluded that dry extrusion led to a significant inactivation of urease activity by 66.67% and crude protein solubility index was 14.72%. This finding makes an extrusion a good choice for thermal treatment of flaxseed intended for usage in broilers chicken nutrition.

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