The influence of corn extrusion in chicken diet

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SUMMARY

Significant physic-chemical changes occur in corn grain structure, due to extrusion, thus positively contributing to its nutritive value, i.e. nutritive components became easily digested by enzymes. Also, corn extrusion is beneficial concerning hygiene and sensor characteristics (sweet taste is becoming more apparent).

The objective of this research is to point at the efficiency of feed meal extrusion in growing chicken diet. Experiment was carried on 3000 chickens, hybrid ROSS. Chickens were divided in two groups, experimental and control. Growing period was 49 days. The diet was the same for both groups of chickens, except in the experimental group corn was replaced with extruded corn.

In growing period up to 42 days, chickens fed with diet containing extruded corn grew more rapidly, had higher weight gain (1985 g), with less consumed feed (2644 g) in comparison to control group (1940 g; 2685g). Mortality also decreased (20:96).

Concerning this data, the use of extruded corn in growing chicken diet is beneficial.

Keywords: chicken growing, extrusion, corn

INTRODUCTION

Food processing is extremely important activity, both in developed and non-developed countries. Having in mind that human population is growing, the lack of food is making this problem more evident.

Increased production of human food and animal feed can be attained by applying new technologies in the biotechnology, i.e. biotechnology, (Lazarević, et al., 2005). Basic orientation is either toward new technological processes witch contribute to increased food or feed nutritive value or giving extra value to by-products from food industry and from primary agricultural production.

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Today in the world a variety of thermal processes is applied for treating oilseeds and cereals: toasting, extrusion, hydrothermal treatment, micronization, micro wave treatment or dielectic thermal treatment (Sakač at al., 1996, Marssman et al., 1998) but in Serbia extrusion and hydrothermal processes are in common practice (Sakač at al., 1996, Filipović et al., 2007).

In domestic feed production, in comparison to other cereals, corn is having a leading position due to high energy (16,2MJ/kg), starch and fat but low cellulose level. It is considered that corn, beside the best digestibility, in comparison to other cereals, also has the best taste (Bekrić, 1999).

Appropriate temperature in extrusion process can reduce the content of thermally unstable anti-nutrients at acceptable level and improve the digestibility of some nutrients (protein, fat, carbohydrates), also sensor characteristics and microbiology of the product (Verheul, 1997; Kormanjoš, 2007) Along with the reduction of anti-nutrient content, it is necessary to preserve thermolabile nutritive components, therefore process need to compromise these two demands (Jansen, 1991).

Thermal treatment of cereals is commonly practiced for the improvement of their nutritive value, hygiene, physic-chemical and other characteristics, that way positively contributing to increasing nutritive value of certain nutrients, sensor characteristics (increasing corn sweet taste due to extrusion) and inactivation of thermally unstable anti-nutrients if present.

Extrusion of corn, which is a basic raw material in feed production, as well as, extrusion of corn dry milling by products is contributing to better feed utilization in animal fattening (Filipović et al., 2008).

Due to extrusion, carbohydrates from corn meal are undergoing to certain changes resulting in starch content decrease and therefore in dextrin content increase, also to the inactivation of amylase inhibitors. Concerning the fact that gelatinized starch is easily digested by enzyme these changes are in favor of either *in vitro* or *in vivo* starch digestibility (Douglas et al., 1992; Filipović et al., 2003).

The objective of this research is to determine the efficiency of corn extrusion in growing chicken diet.

MATERIAL AND METHODS

Chicken feeding

The experiment was carried on 3000 chickens, hybrid ROSS. Chickens were divided in two groups, (experiment 0) and control group (Control K) and fed under the same conditions in the period of 49 days. The diet was the same for both groups of chickens, except in the experimental group corn was replaced with extruded corn. Up to 21 day chickens in both groups were fed with starter diet than followed finisher formulation. During whole chicken growing period water and feed were fed *ad libitum*. Every 7 days body weight was tested. After growing and 12h starving period, chickens were slaughtered, body mass was weighted and data statistically interpreted according to computer program Origin.

Chemical procedures

Basic chemical composition (moisture, crude proteins, crude cellulose, crude fat and mineral matters) of chicken feed was determined according to official A.O.A.C. methods (1984). Starch and total reducing sugars were determined according to the Regulations for methods for quality control of cereals, milling and bakery products, pasta and frozen dough (1988). Content of following elements: calcium, phosphorus, and test weight are determined according to Regulations for methods for sampling and methods for feed physical, chemical and microbiological analyses (1987).

Nitrogen solubility index was determined according to official A.O.C.S. method (1973).

Microbiology

Microbiology, total number of microorganisms, yeast and mold count, separation and *Salmonella* and sulphytoreducing clostridia species identification were done in accordance with the Regulation for methods for microbiology analyses and super analyses of food (1980).

Presence of *Coagulase positive staphylococcus*, *Proteus* species and *Escherichia coli* was determined according to our modified method. Modification is concerning sample preparation: 50 g of sample was weight into e-flask and incubated in 450ml of sterile media at 37˚ for 24h. Isolation and identification was according to above mentioned Regulations for method for microbiology analyses (1980).

Corn extrusion

Corn with moisture content of 12% was grinded on a hammer mill having Ø 5 mm sieve openings, than tempered to 18% moisture.

Corn was extruded in extruder with following characteristics: capacity, 900 kg/h; installed power of extruder, 100 kW; power of worm dosing device, 1,1 kW; extrusion temperature 90 and 95˚C; and die diameter 7,5 mm.

RESULTS AND DISCUSSION

First two weeks, chickens were fed with starter diet formulation (table 1) and than followed finisher formulation where extruded corn was introduced in the experimental group instead of untreated corn which was in the control.

Common reason of complete feed diet incorrectness is increased mold count. Plant origin nutrients have a significant share in diet formulation. Feed nutrients are favorable medium for microorganisms, particularly molds. The main contamination source is the ground. Its composition and micropopulation depend on the ground type, applied agrotechnik, climate, manure and other factors (Dimitrijević, 2003).

Table 1. Composition of the diet

Feedstuff (%)	Starter	Finisher I	Finisher II
Corn	50	56	52
Soybean grits	20	20	17
Soybean meal	22	10	5
Sunflower meal	-	5	10
Short	-	-	8
Yeast	3.5	3.5	3.0
Fat	-	3.5	3.0
Limestone	1.7	1.5	1.5
Monocalciumphosphate	1.45	1.10	1.00
Salt	0.35	0.40	0.50
Premix	1.0	1.0	-
Lysine	0.1	0.1	-
Methyonine+cistine	0.15	0.15	
Chemical composition			
Moisture	12.52	12.24	12.37
Crude protein	22.55	19.93	19.14
Crude fat	5.85	7.57	7.56
Crude cellulose	2.35	3.11	4.09
Mineral matters	5.30	5.20	5.50
Calcium	0.95	0.81	0.74
Phosphorus	0.72	0.65	0.64

Microbiology of corn before and after extrusion is presented in table 2.

Table 2. Content of microorganisms in corn and extruded corn

Microorganism	Number	Non-treated corn	Extruded corn
Salmonella sp.	In 50 g	0	0
Coagulasa positive *Staphylococcus*	In 50 g	0	0
Sulphytoreducing *Clostridia*	In 1 g	0	0
Proteus	In 50 g	0	0
Echerichia coli	In 50 g	0	0
Total number of molds	In 1 g	63,000	55
Total number of yeasts	In 1 g	45,000	0
Total number of microorganisms	In 1 g	1,200,000	310

In the tested diet, molds, yeasts and other microorganisms were present. Feed with higher moisture (more than 14%) is extremely convenient for the microorganisms. Commonly detected molds are belonging to *Aspergillus, Penicilium, Fusarium, Mucor* etc. (Adamović et al., 2001).Prior to extrusion 63.000 molds were present in corn and due to extrusion the count was only 55 per 1g. Total number of microorganisms also significantly decreased after corn extrusion. Sulphytoreducing clostridia were not detected in both corn samples. Similar data were practiced by others (Kormanoš et al., 2007). Though extrusion temperature and duration are relatively low 90-125°C and 6-10 s, respectively, but a significant decrease in total number of microorganisms is evident, probably due to very high pressure, 30-40 bar, table 2.

The nutritive and chemical characteristics of non-treated and extruded corn are presented in table 3. After tempering moisture of 17.6% of ground corn is favorable for corn extrusion process under so called controlled temperature conditions. Moisture content round 20% is also recommended by Venou et al., (2003) as an optimum concerning extrusion of wheat and corn.

Table 3. Chemical composition of untreated and corn extruded at 90 and 95°C

Quality characteristics	Non-treated corn		Corn extruded at 90°C		Corn extruded at 95°C	
Moisture (%)	17.60	D.M. basis	9.07	D.M. basis	5.25	D.M. basis
Crude protein (%)	7.62	9.25[b]	8.25	9.07[c]	8.50	8.97[a]
Crude ash (%)	1.51	1.83[b]	1.42	1.56[a]	1.500	1.58[a]
Crude cellulose (%)	2.84	3.45[c]	2.25	2.47[a]	2.65	2.80[b]
Crude fat (%)	3.96	4.80[c]	1.89	2.08[a]	2.52	2.66[b]
NSI	13.11	15.91[b]	6.06	6.66[a]	5.88	6.21[a]
Starch (%)	58.42	70.90[c]	60.98	67.06[b]	61.55	64.98[a]
Total sugars (%)	0.82	1.00[a]	3.63	3.99[a]	3.90	4.12b
Reducing sugars (%)	0.33	0.40[a]	0.38	0.42	0.43	0.45[a]

D.M. – dry matter
Mean values of quality characteristics expressed on dry matter basis with the same exponent in the row are not statistically different ($p<0.05$).

Chemical characteristics of corn extruded at temperatures of 90 and 95°C are presented in table 3. The decrease of moisture (table 3) after corn extrusion is statistically significant ($p<0.05$) therefore extruded is characterized by a long shelf-life, i.e. it is suitable for storing.

In comparison to untreated corn, dry extrusion contributed to statistically significant changes ($p<0,05$) in crude fat i.e. crude fat decreased 57 and 45% at temperatures of 90 and 95°C, respectively, (table 3). Similar fat reduction round 60% after corn extrusion at 115-125°C was also reported by Venou et al., (2003). Though extrusion is contributing to fat content decrease, extruded products may undergo lipid oxidation due to increased area that is in contact with the air (Namiki, 1990). Camire and Dougherty (1998) also reported that extruded products are susceptible to lipid oxidation due to low moisture content and increased air contact area, but lipogenaze thermal inactivation is lessening this process.

During extrusion, corn carbohydrates are undergoing significant physic-chemical changes, which are influencing starch digestibility and utilization. Due to extrusion, starch is gelatinized and therefore its structure is being degraded and more accessible to enzyme in stomach (Douglas et al., 1990; Zhou and Erdam, 1995). In comparison to non-treated corn, starch content in extruded corn is according to statistic data, ($p<0.5$), significantly lower and, as a consequence, there is an increase of reducing sugars, (table 3) which contributes to the change of sensor characteristics i.e. slightly sweet taste is registered in extruded products.

Basic data concerning chicken growing with diets containing extruded or untreated corn are presented in table 4.

Table 4. Basic data of chicken growing

Period (days)	O				K			
	Body weight (g)	Total feed usage (g)	Mortality (number)	Chicken number	Body weight (g)	Total feed usage (g)	Mortality (number)	Chicken number
0	44.2			1.500	44.2			1.500
0-7	127.5	200	6	1.494	111.5	215	10	1.490
0-21	565.0	1.250	8	1.486	519.0	1.265	53	1.437
0-28	966.0	2.250	2	1.484	907.0	2.255	23	1.414
0-35	1.490.0	3.650	1	1.483	1.420.0	3.645	3	1.411
0-42	1985.0	5.250	2	1.481	1.940.0	5.210	3	1.408
0-49	2.760.0	8.350	1	1.480	2.780.0	8.330	4	1.404

If extruded corn was included in the diet, chickens grew faster, had better body weight, utilized less feed per kg of body gain in comparison to chickens in control group.

In chicken growing, the most evident positive result of the diet with extruded corn, low mortality should be emphasized. In control and experimental group total number of dead chickens was 96 and 20, respectively, so concerning better chicken health, the great advantage of extruded corn in the diet is obvious. This result is particularly characteristic within first four weeks of chicken growing.

The other fact, significant for total production effects and realized economic data is the feed conversion. Calculation of realized feed conversion point at the better results in experimental group, i.e. in the diet with extruded corn. Feed conversion of total experimental and control group was 2,04 kg and 2,13 kg of feed per one kg of body gain, respectively. Better insight in feed conversion can give the change of feed conversion during growing period. Survey was done according to available data and it is presented at fig.1.

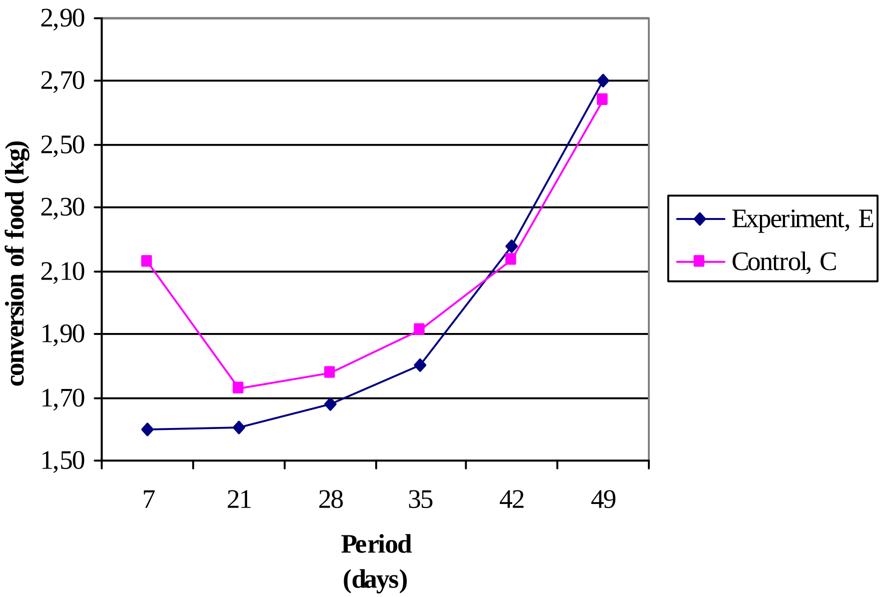

Fig. 1. Conversion of food during the fattening of poultry

From fig. 1 it is evident that diet containing extruded corn is beneficial at the beginning of chicken growing. That is one more proof of extruded corn positive performance concerning younger animals. Related to the data from table 1 it is possible to conclude that the feed consumption is nearly the same in both groups. I should be stressed that experimental group, due to lower mortality, had greater number of chickens at the end of growing period, thus on the whole, better production results were experienced if extruded corn was included in the diet.

CONCLUSIONS

Based on presented data it can be concluded that, in comparison to chickens in control group, extruded corn in the diet contributed to faster growth, better body weight and feed utilization per kg of body gain and lower mortality.

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