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The use of nuclear technology on soybean meal and corn on blood biochemical parameters in broiler breeder

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Abstract

The aim of the present study was to determine effect of Electron Beam Irradiation (EBI) on nutritional value of corn and soybean meal in poultry. Sixteen Rosters and 80 Hen Ross 308 (46-week-age) with an average BW of 5.71 and 4.65, respectively, were randomly distributed into 4 treatment group (4 repeated cage for each treatment) and received experimental diets (at 0, 30, 40 and50 KGy levels) as a NRC requirements needs. At the end of study from each repeated cages 2 hens selected randomly and 5cc blood sample was taken using wing vain using disposable syringe. . Blood samples were centrifuged at 5000 rpm for 10 minute and plasma was separated and stored at -20 °c until used. Plasma Total Protein (TP), Albumin (ALB), Glucose (Glu) and Uric Acid concentration were determined by calorimetric method. According to the results there were a significant differences in Total protein, Albumin and Glucose levels between treatment groups compare to control group (*P=<0.05*). Also, there was no significant difference in uric acid variables between experimental groups during the study (*P=>0.05*).

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Introduction

The nutritional and economic importance of energy in the formulation of least-cost diets for poultry industry and the increasing poor profitability of commercial poultry production are sustaining interest in the Metabolizable Energy (ME) values of diets. Many approaches traditionally have been followed to generate ME values and feed (McNab, 2000). Protein is most important and expensive part of the ratio. Therefore, scientists researched in this field to find a method to enhanced protein and carbohydrate degradation, degradability; overall, improving animal performance. Among various processes feed stuffs degradation, radiation-chemical degradation occupies an important place. Previously researchers demonstrated that despite the environmental and economic benefits of Electron beam irradiation (EBI) treatment as compared to X-ray and γ-irradiation, Electron beam modification of proteins has been studied to a lesser extent. The two most commonly used sources of irradiation are gamma rays and electron beams (Lewis *et al.,* 2002). Electron beam irradiation is used for enhancement of molding of starch blends with synthetic polymers (Shishonok *et al.,* 2007). Electron beam irradiation has many benefits in animal products e.g. use of irradiation to improve the safety of meat and poultry products to control *Trichinella spiralis* in pork (Lewis *et al.,* 2002). Also, previous researchers reported that electron beam irradiation results in an increase in the amount of cholesterol oxides that are formed in poultry meat (Lee *et al.,* 2001).

Gamma irradiation induces physico chemical changes in proteins. Chemical transformations of amino acids, breakdown of hydrogen and disulphide bridges, peptide bonds, and as well as cross linking of the chains influence of the tertiary structure of proteins and their physico chemical properties (Ciesla *et al.,* 2000). Many results were reported by previous researchers about using EBI in starch (Saint-Lebe *et al.,* 1978; Shishonok *et al.,* 2007). Shawrang *et al.,* (2008) reported irradiation of oilseeds was successful in reducing degradation of CP by rumen microorganisms. Corn and soybean meal are the most common feed stuffs and widely used in commercial poultry production in the world (Wan,*et al.,* 2009) but because of climate culture and price, it's one of the expensive feed gradients and in most developing countries is one of the importable, so corn usage in poultry industry is dependent to price (Choct *et al.,* 1992). Irradiation is a processing technique that influences protein structure and it has been shown that irradiation may result in cross-linking and aggregation of proteins (Taghinejad-Roudbaneh *et al.,* 2010).

The main propose of this study was to investigate the effectiveness of EBI on blood biochemical parameters in broiler breeder.

Material and methods

Sample collection

At the end of study from each repeated cages 2 hens selected randomly and 5cc blood sample was taken using wing vain using disposable syringe. Blood samples were centrifuged at 5000 rpm for 10 minute and plasma was separated and stored at -20 ^{o}c until used. Plasma TP, Alb, Glu and Uric Acid concentration were determined by calorimetric method using auto analyzer (300 ALCYON).

Sample preparation and irradiation treatments

The corn sample (Brazilian variety) was obtained from the Fajr Company (Tehran, Iran). Eight kg corn sample was divided into four equal portions and packed in polyethylene bags. Three poly-ethylene packages samples were exposed to 10 Mega Volte (MeV) electron beam using a Rhodotron accelerator model TT-200 (IBA Co., Belgium) installed at the Yazd irradiation center, Radiation Applications Research School (of Atomic Energy Organization of Iran) by various levels (0, 30, 40 and 50 kGy). All irradiations were performed at laboratory temperature. Regarding the low thickness of the samples packages, single sided irradiation has been used. The required doses were delivered to the samples by adjusting the conveyer speed when each of the sample batches passed under the beam.

Experimental birds

Sixteen Rosters and 80 Hen Ross 308 (46-week-age) with an average BW of 5.71 and 4.65, respectively, were randomly distributed into 4 treatment group (4 repeated cage for each treatment) and received experimental diets as a NRC mentioned needs. All experimental birds had free excess to fresh water during the study. At the first hours of experiment to decrease effect of stress 10 ml /10 lit water vitamin supplements was given to birds.

Experimental Diet

All experimental diets are formulated by NRC 2001 suggestions using User Friendly Feed Formulation Done Again (UFFDA). All experimental diet was Iso-caloric and Iso-nutrigenous. There was difference just between EBI levels of corn and soybean meal. The compositions of experimental diets are shown in table 1 and 2. All experimental birds received experimental diets for 8 week.

Statistical analysis

Data were analyzed as a complete randomized design (CRD) using SAS (9.1) software and the least square means compared with Duncan's multiple range tests. Statistical model used in this study was: $Yij=\mu+Ti+eij$

Result and discussion

Effects of nuclear Irradiated soybean and corn on blood biochemical parameters in broiler breeder are shown in table 1. According to the results there were a significant differences in TP, Alb and Glu levels between treatment groups compare to control group (*P=<0.05*). Also, there was no significant difference in uric acid variables between experimental groups during the study (*P=>0.05*). According to our results there was an increase in TP levels which the highest level of TP was observed in group D which consumed diet Irradiated 50 Kgy. Also, there was similar observation in Alb levels among the experimental groups which increasing Irradiation levels caused to increase Alb levels. Simultaneously, we observed similar results in Glu levels between the experimental animals which the lowest was for group A (control) whereas the highest level was observed in group D (which consumed diet Irradiated 50 Kgy).

Radiation processing via gamma irradiation involves the use of a radioactive isotope, either in the form of cobalt-60 or cesium- 137, which emits high-energy gamma rays or photons capable of intruding in-depth into the target product, up to several feet. In the case of electron beam irradiation, the technology uses a stream of high-energy electrons generated from machine sources (such as linear accelerators, microtron). However, negative perception among consumers and debate on the use of gamma rays for food products still persists. A few of the studies were undertaken relevant to irradiation of starch. A likely enhancement in maltose, maltotriose, and maltotetrose production along with structural changes on irradiation has been reported in wheat starch (Ananthaswamy *et al.,* 1970a, 1970b). Those researchers observed irradiated samples to be highly sensitive to the action of α- and β-amylase enzymes, in comparison to unirradiated samples. El Saadany *et al.,* (1974) evaluated the effects of gamma irradiation on rice starch, and from the results obtained, a modification was evident wherein the reducing power was increased and degradation as well as molecular breakdown occurred, with a sharp decrease in viscosity, specific viscosity, and intrinsic viscosity. Higher starch solubility was observed with radiation treatments, as was decreased swelling capacity. In wheat, a significant decrease in the amylograph peak viscosity and dough stability has been reported with increased radiation levels (MacArthur and D'Appolonia 1983; Ng *et al.,* 1989). Kerf *et al.,* (2001) evaluated the disintegrating properties of starch products (corn, potato, and drum-dried corn starch) irradiated by X-rays and electron beams (0, 10, 15, and 100 kGy). The disintegration properties of the starches were compared using α-lactose monohydrate tablets containing 5% (w/w) starch as a disintegrant. It was observed that, with an increase in irradiation dose, there was a subsequent increase in starch solubility accompanied by a decrease in the swelling capacity. Irradiation treatments modified different starches and were observed to cause fragmentation of the amylopectin fraction, as these molecules became smaller in molecular weight with irradiation dose and merged with the amylose fraction. Hence, the decreased swelling capacities of irradiated starch were assigned to the marked decrease in concentration of the amylopectin fraction. Overall, electron beam irradiation resulted in significantly higher disintegration times of the tablets. The digestibility of starch varies among different starchy foods and has progressively attracted interest among researchers due to its significant role in non-insulin-dependent diabetes treatment (Jenkins *et al.,* 1988). Starch digestibility is influenced by various intrinsic and extrinsic factors (Wurzburg 1986; Colonna *et al.,* 1992). Variations in the digestibility of starch has been ascribed to various factors such as its origin (Go˜ ni *et al.,* 1997), physicochemical properties (Panlasigui *et al.,* 1991), amylose/amylopectin ratio (Juliano and Goddard 1986), and food processing methods employed (Bravo *et al.,* 1998; Sagum and Arcot 2000).

Proteins are large compounds that contain nitrogen, in addition to carbon, hydrogen and oxygen. Some proteins also contain iron; phosphorus and sulfur. The sequences of amino acids in the double-stranded helix chains of the DNA serve as a template for replication during cell division, and are responsible for the synthesis of essential proteins and enzymes that regulate cellular metabolism through the process of RNA transcription. While amino acids by themselves are relatively sensitive to free radical attack following irradiation, they are much less sensitive when buried in the rigid structure of a protein molecule. Consequently, low and medium doses cause only a minor breakdown of food proteins into lower molecular weight protein fragments and amino acids. Previous researchers demonstrated irradiation at doses of 10, 15, 20, 25 and 30 kGy increased the energy digestibility of barley by 5, 9, 19, 24 and 30%, and the protein digestibility by 4, 7, 14, 31 and 35%, respectively, as compared with the raw sample. Increase in the surface hydrophobicity of protein by irradiation occurred duo to breakdown of hydrogen bonds, which result in denaturation of protein, and changes in corn and soybean meal protein conformation to expose more hydrophobic sites (Lacroixa, *et al.,* 2002). In inherent structure of globular proteins, many hydrophobic amino acids are inside the protein molecule. Ionizing irradiation could induce the unfolding of the protein and denaturation, thus exposing non- polar groups that were previously blocked. Hence, irradiations increased the hydrophobicity of protein by exposing non-polar groups. This is a favorable condition for proteins to approach each other and aggregate (Garrison, 1987; Shawrang *et al.,* 2007). Increase in the protein digestibility can be explained by increase plasma TP and Alb levels in experimental birds compare to control group. Additionally we couldn't find any article about effects of EBI on blood uric acid.

Table 1. The compositions of experimental diets for Broiler Breeder in 1000 kg.

ingredients	A	B	C	D
Corn	526	526	526	526
Soybean meal	190	190	190	190
Wheat	160	160	160	160
DCP	11	11	11	11
Shell	40	40	40	40
Calcium Carbonate	35	35	35	35
Barn	28	28	28	28
Vitamine Cop.	2.5	2.5	2.5	2.5
Mineral Cop.	2.5	2.5	2.5	2.5
Salt	2.5	2.5	2.5	2.5
Methionine	0.7	0.7	0.7	0.7
Lysine	0.2	0.2	0.2	0.2
Phytase	0.4	0.4	0.4	0.4
Aluminum Sulphate	1.2	1.2	1.2	1.2

A: 0, B: 30, C: 40 and D: 50 KGy levels on nutritional value of corn and soybean meal

Reports are available wherein the application of radiation treatments is shown to enhance/improve the in vitro starch digestibility (Ananthaswamy *et al.,* 1970b; Kume *et al.,* 1988; Rombo *et al.,* 2001). However, there are still many gaps that have to be filled to provide more insight into the applications involving the improvement of starch digestibility conferred by irradiation treatments. There wasn't similar study in EBI on Broiler Breeder. According to our results we believe different levels of EBI could change natural structure of starch in diet and improved absorption of glucose. We believe this phenomenon was the results of increasing blood glucose content in experimental animals.

Table 2. Calculated values of experimental diets.

	A	B	C	D
ME (Kcal/Kg)	2700	2700	2700	2700
CP (%)	15	15	15	15
P (%)	0.33	0.33	0.33	0.33
Ca (%)	2.9	2.9	2.9	2.9
Met+ Cys	0.62	0.62	0.62	0.62
Lys	0.63	0.63	0.63	0.63

ME: Metabolizable Energy, CP: Crude Protein, P: Phosphorous, Ca: Calcium, Met: Methionine, Cys: Cysteine, Lys: Lysine

Table 3. Effect of different levels of Irradiated soybean and corn on blood biochemical parameters in broiler breeder.

Group	N	Total protein (g/dl)	Albumin (g/dl)	Uric Acid (mg/dL)	Glucose (mg/dL)
A	20	$5.387^{c} \pm 0.72$	$3.744^{b} \pm 0.129$	3.825 ± 0.09	$158.9^{b} \pm 1.39$
B	20	$6.404^{ab} \pm 0.72$	$3.576^{a} \pm 0.129$	3.527 ± 0.09	$172.1^{a} \pm 1.39$
C	20	$6.831^{a} \pm 0.72$	$5.366^{a} \pm 0.129$	3.75 ± 0.09	$175.7^{a} \pm 1.39$
D	20	$6.2^{b} \pm 0.72$	$5.000^{a} \pm 0.129$	3.725 ± 0.09	$172.9^{a} \pm 1.39$
F value		17.483	10.078	0.465	1.333
Prob.		0.0001	0.0013	0.0002	0.0050

A: 0; B: 30; C: 40 and D: 50 KGy. There is a significant difference among groups with different letters (a, b) in protein and other excretion factors values ($P < 0.05$); SE: Standard error.

According to our results, EBI had positive effects in poultry industry but we suggest a lot of researches require identifying all aspects of EBI on broiler breeder.

Conclusion

This study documented the effect of electron beam irradiation at doses of 0, 30, 40 and 50 KGy on blood biochemical parameters in broiler breeder. Irradiation significant effects on plasma Tp, Alb and glucose contents in experimental animals compare to control group. Therefore, irradiation results in a better nutritional quality of corn and soybean meal under investigation in respect to an increase in bioavailability of its components.

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