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GROWTH RESPONSE OF BROILER CHICKENS FED GRADED LEVELS OF YEAST TREATED RAW SOYA BEAN AND FULL FAT SOYA BEAN

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Growth response of broiler chickens fed graded levels of yeast treated raw soya bean and full fat soya bean

The study was designed to determine the effect of replacing Full Fat Soya Bean (FFSB) in parts with Raw Soya Bean (RSB) treated with graded level of yeast in the diet of broiler birds. A total of fifteen diets were formulated whereby RSB replaced FSSB at 0% (control), 25%, 50%, 75% and 100%, but each of these having three levels of treatment with yeast and without yeast as a control. Mean weight gain and final body weight of the broilers followed the same pattern of no differences in treatment means. Results obtained for the entire production period (0–56 days) showed that birds that were fed diet containing 75% FFSB, 25% RSB and 8 g/kg yeast compared favourably with those that were fed the control diet regarding final body weight, weight gain, average daily gain, feed intake, and the feed : gain ratio. Our study revealed that RSB at the levels fed with and without yeast inclusion had no effect on broiler chicken lethality. However, optimal performance was achieved when RSB was fed at 25% with 6 g/kg yeast inclusion at starter phase and at 25% without yeast or 75% with 12 g/kg yeast inclusion at finisher phase.

Key words: poultry / broiler chickens / growth /animal nutrition / soya / yeast

Rast piščancev, krmljenih z obroki z različnimi deleži s kvasovkami obdelane surove in pražene soje

Študijo smo zasnovali z namenom, da bi proučili učinek zamenjave pražene soje s svežo sojo, obdelano s kvasovkami v obroku za piščance. Uporabili smo 15 različnih obrokov, v katerih smo praženo sojo zamenjevali s svežo sojo (0 % (kontrola), 25 %, 50 %, 75 % in 100 %), ki je bila obdelana z različno količino kvasovk, oziroma brez obdelave s kvasovkami. Povprečni prirasti in končna telesna masa brojlerjev nista kazala pomembnih razlik med različnimi obdelavami. Rezultati celotnega poskusnega obdobja (0–56 dni) kažejo, da so imeli piščanci, krmljeni s 75 % pražene in 25 % surove soje, obdelane z 8 g kvasovk/kg v primerjavi s kontrolno skupino višjo telesno maso ob koncu pitanja, višje dnevne priraste, boljšo konzumacijo in konverzijo krme. Naši rezultati kažejo, da vključitev surove soje v obrok nima negativnih posledic za zdravje piščancev. Najboljše rezultate smo dosegli z uporabo 25 % surove soje, obdelane z 6 g/kg kvasovk v štarterju in 25 % surove soje brez obdelave s kvasovkami oziroma s 75 % surove soje, obdelane z 12 g/kg kvasovk v finišerju.

Ključne besede: perutnina / pitovni piščanci / rast / prehrana živali / soja / kvas

1 INTRODUCTION

Globally, there is an insatiable yearning for increased food production, basically due to significant rise in human population which is unfortunately not proportional to the food supply. In addition, livestock industry in the tropics is characterized by many nutritional problems. Increasing competition between man and animals for available grains, inadequate supply of feedstuffs, poor quality feeds among others have been recurring problems in livestock production. The shortage of feed, particularly energy and protein feed has been reported to be more severe in non-ruminant production which depends to a great extent on compounded feed (Akande *et al., 2007*).

The global emphasis on ethanol production has diversified significant proportion of grain away from ani-

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mal production, thus increasing the cost of feed. This has forced the pig and poultry industries to scrutinize their production methods, investigating alternative feed ingredients together with methods of improving productivity and efficiency in order to survive (http://www.allaboutfeed.net/news/id102-43411). An important part of raising poultry is feeding, which makes up the major cost of production and good nutrition is reflected in the bird's performance and its products (NCAT, 1998). Poultry production is vital in economy of Nigeria as the sustained achievement of this will immensely help in the diversification and reshaping of our oil dependent economy. Since protein is generally one of the most expensive feed ingredients, the chicken industry uses targeted rations and reduce the amount of protein in the diet as the birds grow (chickens require less and less protein as they age), however, it may not be cost-effective for small scale-producers to have different diets for starters, growers and finishers (NCAT, 1998).

The use of local, cheap and readily available material, particularly those that are not directly utilized by man has received particular attention as the only viable alternatives to the use of conventional feed stuffs (Akpodiete *et al.,* 1997; Akande *et al., 2007*). The ability of a feed to supply energy for the numerous metabolic processes within the animal's body is of great importance in determining the nutritive value of that feed (Akinmutimi, 2004). The metabolic processes are associated with the maintenance of the body functions, the construction of body tissues, and the synthesis of such products as milk and eggs, and energetic transformations for work done by the animal (Akanno, 1998). As these metabolic processes require a transfer of energy, it follows that the ability of feed to supply energy will be a measure of its nutritive efficiency.

Soya bean meal serves as the world standard in regard to protein meals for livestock production (Kohlmer, 1990; Leeson and Summers, 1997). It is palatable, nutrient dense, highly digestible, and cost effective. Similarly, full fat soya bean (FFSB) was said to possess the same features, but in addition, it is an excellent source of energy and fatty acids (Kohlmeir, 1990). Properly processed full fat soya bean may represent valuable material in diets used within the modern poultry industry because it may make a significant contribution to overall dietary energy level when incorporated with low quality ingredients in the diet of poultry (AKande *et al.*, 2007).

Legumes generally contain anti-nutritional factors such as tannins, saponin, trypsin inhibitors, mycotoxin and several others. Initial studies regarding the use of whole soya bean in animal feed were carried out on poultry, specifically with broilers and laying hens, during the nineteen sixties. Recent review on the subject has been carried out by Liener (1985), Kumar (1990), Coon *et al.* (1990) and others. These investigations indicate that soya beans are an excellent source of protein and energy for poultry, however, the raw grain contains anti-nutritional factors that inhibit productivity, and as a result, prior heating is required. The processing conditions, especially those relating to the milling size, the use of steam, the temperature and the pressure applied, in addition to the process duration, all influence the quality of the final product and define its nutritional value to a large extent in addition to defining advisable levels of use in commercial diets. Recent studies have involved the use of yeast on raw soya bean and encouraging results have ensued.

The inclusion of yeast (*Saccharomyces cerevisiae*) to the milled soya bean has been found to reduce the harmful effect of raw soya bean. Yeast is a naturally rich source of proteins, minerals and B-complex vitamins. In addition, yeast or yeast cell walls can also be used as adsorbents for mycotoxins. Approximately 40% of the weights of dried yeast consist of protein. As a feeding-stuff, yeast is of particular value for the growth of poultry and cattle.

The quality of yeast protein is excellent for a vegetable protein and is about equivalent in quality to soya bean protein (Stone, 1998).There is need to determine experimentally at what levels yeast inclusion will be ideal in mixture with crushed raw soya bean.

This when found will help to ascertain the optimal performances in the broiler chickens in conjunction with graded levels of raw soya bean and yeast inclusion. The information will encourage interest in demand for yeast at more commercial quantities, thereby attracting the patronage of more farmers who hitherto was ignorant of its importance. More so, the increase in the cost of feed production due to the use of heat, urea etc. for soya bean treatment will be abated, thereby improving the income of animal farmers. Consequently, the objective of the study is to investigate the performance of broiler chickens fed graded levels of yeast treated raw soya bean and full fat soya bean.

2 MATERIALS AND METHOD

2.1 THE EXPERIMENTAL SITE

This study was carried out in the poultry unit of the Teaching and Research Farm of the Delta State University, Asaba Campus. The farm is located on Longitude 60° 45 /E and Latitude 60° 12 /N, with an annual rainfall that ranges from 1800 mm to 3000 mm, and also with the maximum day temperature range of 27.5 °C to 30.9 °C.

One of the poultry houses at the Teaching and Research Farm was used for this study. The house was internally restructured to meet the research requirements.

The poultry house and its environment was kept in good sanitary condition, with the interior properly swept, washed, disinfected and allowed to stand for two weeks. This is to allow the strong odour of the disinfectant to thin out for the health of the chicks. Thereafter, a fresh litter of wood shavings were spread on the floor of the pens, and the shavings were changed from time to time.

2.2 THE EXPERIMENTAL DIETS

2.2.1 THE TEST INGREDIENT

The test ingredient was soya bean. The soya bean was purchased at Ose market in Onitsha, Anambra State. The soya bean to be used was divided into two equal parts for the respective preparatory methods of the soya bean processing before inclusion in the diets. One part of the soya bean was roasted. Because the oil inherent in the soya bean is not extracted after the roasting, it is designated as full fat soya bean (FFSB). The remaining part of the Soya bean is left in its raw state; hence it is designated as raw soya bean (RSB). Both the FFSB and RSB were crushed before use.

With the exclusion of the first group diets which have 100% FFSB, 100% RSB and a combination of 75% FFSB and 25% RSB respectively, the rest test ingredients have various levels of yeast inclusion. The second group test ingredients consist of a combination of 75% FFSB and 25% of RSB, the third group is a combination of 50% FFSB and 50% RSB, the fourth group is combination of 25% FFSB and 75% RSB, while the fifth group test ingredients consist of 100% RSB. Furthermore, each of 2nd, 3rd, 4th and 5th group test ingredients was partitioned into three equal portions, whereby graded levels of powdered yeast on the progressive order of 6 g, 12 g, and 18 g of yeast /1kg of soya bean were incorporated into the test ingredients.

The yeast product which contained natural yeast (*Saccharomyces cerevisiae*) was purchased in an aluminium foil container of 450-gramme weight. Then it was first prepared into pastry in warm water before it was mixed with the crushed soya bean. Each of these treated portions of soya bean is packaged into cellophane bags and tied. They were left in this form for 18 hours. Each portion was thereafter incorporated into other ingredients to form a normal standard broiler ration. Thus fifteen diets were compounded, different by the various combinations of roasted and raw soya beans and level of yeast treatment. The first three diets were devoid of yeast treatment.

Table 1: *Proximate composition of the broiler starter diets (% dry matter)*
Preglednica 1: *Sestava obroka za brojlerje s štarterjem (% suhe snovi)*

Treatment	% Dry matter	% Crude protein	% Crude fibre	% Ether extract	% Ash	% NFE	ME (kcal/kg)
T1	89.50	23.40	1.10	5.00	15.50	44.49	2954.20
T2	88.49	23.25	1.08	2.00	15.20	46.96	2790.93
T3	88.78	23.30	1.20	9.50	8.50	46.28	3382.14
T4	89.00	23.69	1.11	3.00	12.50	48.79	2950.65
T5	88.50	23.65	1.08	5.50	8.50	49.87	3190.57
T6	88.52	23.62	1.05	4.50	8.50	51.85	3182.72
T7	88.65	23.50	1.31	1.50	12.50	49.84	2861.57
T8	88.38	23.55	1.61	2.50	1.50	50.22	2957.01
T9	88.50	23.58	1.50	2.50	9.50	51.42	3002.37
T10	88.49	23.55	1.49	11.00	10.00	43.45	2718.33
T11	90.02	23.57	1.40	4.79	7.50	52.76	3236.89
T12	88.36	23.55	1.21	4.05	10.50	50.55	3079.42
T13	89.45	23.05	1.33	5.05	13.00	47.02	3035.15
T14	88.40	23.25	1.13	3.70	14.00	47.32	2942.77
T15	88.42	23.20	1.21	4.02	14.50	46.49	2937.64

Where; T1 = 100% Full fat Soya Bean (FFSB), T2 = 100% Raw Soya Bean (RSB), T3 = 75% FFSB + 25% RSB, T4 = 75% FFSB + 25% RSB + 6 g/kg yeast, T5 = 75% FFSB + 25% RSB + 12 g/kg yeast, T6 = 75% FFSB + 25% RSB + 8 g/kg yeast, T7 = 50% FFSB + 50% RSB + 6 g/kg yeast, T8 = 50% FFSB + 50% RSB + 12 g/kg yeast, T9 = 50% FFSB + 50% RSB + 18 g/kg yeast, T10 = 25% FFSB + 75% RSB + 6 g/kg yeast, T11 = 25% FFSB + 75% RSB + 12 g/kg yeast, T12 = 25% FFSB + 75% RSB + 18 g/kg yeast, T13 = 100% RSB + 6 g/kg yeast, T14 = 100% RSB + 12 g/kg yeast, T15 = 100% RSB + 18 g/kg yeast

***Table 2:** Proximate composition of the broiler finisher diets (% dry matter)*
***Preglednica 2:** Sestava obroka za brojlerje s finišerjem (% suhe snovi)*

Treatment	% Dry matter	% Crude protein	% Crude fibre	% Ether extract	% Ash	% NFE	ME (kcal/kg)
T1	88.90	20.87	1.45	4.20	15.50	46.88	2879.99
T2	88.49	20.61	1.32	1.89	15.20	49.47	2773.36
T3	88.40	21.02	1.60	8.50	8.50	48.78	3152.24
T4	88.35	21.05	1.50	2.85	12.50	50.45	3304.73
T5	88.40	21.00	1.33	5.00	8.50	52.57	2902.96
T6	88.50	21.01	1.30	4.20	8.50	53.49	3119.83
T7	88.49	20.68	1.78	1.41	12.50	52.12	2977.18
T8	88.30	20.58	1.85	2.00	11.50	52.37	2892.34
T9	88.50	20.49	1.80	2.10	9.50	54.61	2968.57
T10	88.42	20.55	1.71	2.50	10.00	53.66	2969.78
T11	88.72	20.58	1.68	4.20	7.50	54.76	3149.00
T12	88.40	20.51	1.66	3.85	10.50	51.88	3015.54
T13	88.71	19.98	1.80	4.75	13.00	49.18	2846.91
T14	88.98	20.01	1.61	3.00	14.00	50.36	2873.55
T15	88.70	20.02	1.70	3.20	14.50	49.28	2851.94

Where; T1 = 100% Full fat Soya Bean (FFSB), T2 = 100% Raw Soya Bean (RSB), T3 = 75% FFSB + 25% RSB, T4 = 75% FFSB + 25% RSB + 6 g/kg yeast, T5 = 75% FFSB + 25% RSB + 12 g/kg yeast, T6 = 75% FFSB + 25% RSB + 8 g/kg yeast, T7 = 50% FFSB + 50% RSB + 6 g/kg yeast, T8 = 50% FFSB + 50% RSB + 12 g/kg yeast, T9 = 50% FFSB + 50% RSB + 18 g/kg yeast, T10 = 25% FFSB + 75% RSB + 6 g/kg yeast, T11 = 25% FFSB + 75% RSB + 12 g/kg yeast, T12 = 25% FFSB + 75% RSB + 18 g/kg yeast, T13 = 100% RSB + 6 g/kg yeast, T14 = 100% RSB + 12 g/kg yeast, T15 = 100% RSB + 18 g/kg yeast

The proximate composition of the test diets was determined using the AOAC (1990) procedure.

2.2.2 EXPERIMENTAL DIETS

Fifteen broiler starter and finisher diets were formulated for the starter phase (0–28 days) and finisher phase (29–56 days), respectively. The diets in each phase were formulated to be isocaloric and isonitrogenous with the starter diets containing approximately 2900 kcal/kg ME and 23% crude protein, and the finisher diets containing approximately 3000 kcal/kg and 20% crude protein. The proximate/ nutrient compositions of the formulated/ experimental diets are presented in tables 1 and 2.

2.3 THE EXPERIMENTAL BIRDS AND THEIR MANAGEMENT

One hundred and eighty (180) days old Marshal broilers were procured from Fidan Hatcheries located at Oluyele Industrial Estate, Ibadan, for the study. The chicks were on arrival randomly allotted to fifteen treatments groups of six (6) chicks each in two replicates. Ideal management conditions were maintained.

The chicks were given an anti- stress formulation in their drinking water on the first day to relieve them of their transportation stress. They were fed the experimental starter diet from the first day of arrival for the rest of the 4- weeks breeding period. Feed and clean, cool drinking water were provided *ad libitum*. The broilers were vaccinated against Gumboro and Newcastle diseases at 2 and 3 weeks of age, respectively. Prophylactic doses of coccidiostat, Pantacox (Pantex Holland) were regularly provided in their drinking water at a dose of 1ml/litrer of water.

At the end of the starter phase (on the 29th day of age), the broiler chicks were then thoroughly mixed up and randomly allocated into fifteen dietary treatment groups for the finisher phase. Each treatment group was replicated twice with six (6) birds per replicate and twelve (12) birds per dietary treatment. Feed and clean, cool water were provided *ad libitum* and all necessary medications were administered. Data on live weight, live weight gain, feed intake and mortality were recorded for each replicate weekly.

2.4 DATA COLLECTION

Data on live weight, weight gains, feed intake and mortality were recorded weekly on replicate basis for the period of the starter experiment.

2.4.1 LIVE WEIGHT GAIN, FEED INTAKE AND FEED EFFICIENCY

The initial weight of the chicks was measured on arrival before they were distributed into pens for breeding. They were thereafter weighed at weekly intervals throughout the experimental period. The mean weekly live weight gain (LWG) was obtained according to the formula,

$$LWG = \frac{W1 - W2}{N}$$

where W_1 is the weight of the first week, W_2 the weight of the second week, and N the number of birds in each replicate.

Feed intake: to obtain the feed intake, the chicks were supplied a weighted quantity of feed daily, the leftover feed was always collected the next morning before feeding, air dried, and weighed and subtracted from the weight of the feed provided initially.

Thus the feed intake = initial weight of feed – the weight of the left over feed

$$\text{Mean daily intake} = \frac{\text{daily feed intake}}{\text{number of birds in the replicate}}$$

2.4.2 FEED EFFICIENCY

This was obtained by dividing the weight gain of the birds in each replicate by the total amount of feed consumed during the same period of time by the number of birds in that replicate.

$$\text{Thus feed efficiency} = \frac{\text{weight gain}}{\text{feed consumed}}$$

2.4.3 PERCENTAGE MORTALITY

The percentage mortality was determined per replica as follows:

$$\%\ \text{mortality} = \frac{[\text{No. of dead birds in the replicate}]}{[\text{initial no. of birds in the replicate}]} \times 100$$

2.4.4 METABOLIC TRIALS

At the end of the four weeks of feeding the experimental broiler diets to the broiler finisher, two birds weighing close to the treatment mean weight were selected from each replicate for a metabolic trial. The birds were kept single in battery cages and feed their respective experimental finisher diet. Feeds and water were provided ad libitum. After an initial adjustment period of three days, dropping trays covered with aluminium foil were placed under the birds for total excreta collection for three days. Care was taken to ensure that the faecal materials were oven – dried at 60–80 ^{o}C, then pooled on replicate basis, weighed and ground. The amount of feed consumed over the metabolic trials period was recorded. Representative samples of the faeces and of the experimental diets were then analysed for their respective proximate compositions.

2.5 THE EXPERIMENTAL DESIGN AND DATA ANALYSES

The experimental design was a one- way classification in a completely randomized design (CRD) with the following model:

$$X_{ij} = \mu + \alpha_i + e_{ij}$$

where X_{ij} is the observed value of each of the response variables (performance characteristics) arising as a result of:

μ = the overall population mean.

α_i = observed effect of the i-th dietary treatment

e_{ij} = random or residual error due to the experimentation

All data collected were subjected to analysis of variance (Steel and Torrie, 1980). Means showing significant differences were separated using the Duncan's Multiple Range Test (Duncan, 1955).

3 RESULTS

3.1 PERFORMANCE CHARACTERISTICS OF BROILERS FED THE EXPERIMENTAL DIETS

Results on the performance of the experimental chickens at the starter phase (0–28 days) and finisher phase (29–56 days), and starter to finisher phase (0–56 days) are presented in tables 3, 4 and 5, respectively. During the starter phase, the mean final body weights and the mean weight gains per bird varied significantly ($P < 0.05$) among dietary treatments. Birds fed 75% FFSB

***Table 3:** Performance characteristics of broilers fed the starter diets*
***Preglednica 3:** Rezultati pitanja brojlerjev s štarterjem*

Treatments	Initial body wt. (g/bird)	Final body wt. (g/bird)	Wt. gain (g/bird)	Av. daily gain (g/bird/day)	Feed intake (g/bird/day)	Feed : gain ratio	Mortality (%)
T1	35.50^{cd}	525.00^{abcd}	489.50^{abcd}	17.49^{abcd}	35.00^{bcd}	2.00^{d}	0.025^{b}
T2	36.50^{bcd}	450.00^{d}	413.40^{d}	14.77^{d}	39.500^{abc}	2.67^{abc}	0.020^{b}
T3	37.00^{bc}	570.00^{abc}	533.00^{abc}	19.04^{bc}	40.50^{ab}	2.05^{d}	0.015^{b}
T4	35.75^{bcd}	585.00^{ab}	549.00^{ab}	19.62^{ad}	41.00^{ab}	2.08^{d}	0.015^{b}
T5	39.50^{a}	590.00^{a}	554.00^{a}	19.79^{a}	42.50^{a}	2.15^{cd}	0.000^{b}
T6	35.00^{d}	520.00^{abcd}	480.50^{abcd}	17.16^{abcd}	37.00^{bc}	2.16^{bcd}	0.110^{a}
T7	35.50^{cd}	585.00^{ab}	549.75^{ab}	19.64^{ab}	39.00^{abc}	1.99^{d}	0.030^{b}
T8	35.15^{cd}	525.00^{abcd}	489.50^{abcd}	17.48^{abcd}	41.00^{ab}	2.38^{abcd}	0.065^{ab}
T9	37.50^{b}	500.00^{abcd}	464.50^{abcd}	16.61^{abcd}	39.00^{abc}	2.35^{abcd}	0.065^{ab}
T10	36.00^{bcd}	520.00^{abcd}	482.50^{abcd}	17.24^{abcd}	40.00^{abc}	2.33^{abcd}	0.105^{a}
T11	35.25^{cd}	465.00^{cd}	429.00^{cd}	15.33^{cd}	38.50^{bc}	2.52^{abcd}	0.105^{a}
T12	36.50^{bcd}	475.00^{bcd}	439.75^{bcd}	15.71^{bcd}	36.50^{bc}	2.33^{abcd}	0.070^{ab}
T13	36.50^{bcd}	510.00^{abcd}	437.50^{cd}	16.91^{abcd}	41.00^{ab}	2.47^{abcd}	0.110^{a}
T14	37.50^{b}	460.00^{cd}	422.50^{cd}	15.09^{cd}	40.50^{ab}	2.69^{ab}	0.115^{a}
T15	39.50^{a}	475.00^{bcd}	420.50^{cd}	15.02^{cd}	42.50^{a}	2.83^{a}	0.100^{a}
SEM	0.27	10.67	10.72	0.38	0.48	0.05	0.009

a,b,c; means with the same superscripts within each column, are significantly ($P < 0.05$) different; SEM = Standard error of the means

+ 25% RSB + 12 g/kg yeast had higher ($P < 0.05$) final body weight than those maintained on 100% FFSB, 25% FFSB + 75% RSB + 12 g/kg yeast, 100% RSB + 12 g/kg yeast, and 100% RSB + 18 g/kg yeast. Birds fed standard meal (control treatment) differed significantly ($P < 0.05$) from birds on 75% FFSB + 25% RSB + 12 g/kg yeast, 75% FFSB + 25% RSB + 8 g/kg yeast treatments, 50% FFSB + 50% RSB + 18 g/kg yeast, 100% RSB + 12 g/kg yeast, and 100% RSB + 18 g/kg yeast, in all the three parameters.

The highest feed intake ($P < 0.05$) during the starter phase was recorded in the chicks fed 25% RSB with 12 g yeast inclusion and 100% RSB with 18 g yeast inclusion, while the lowest feed intake ($P < 0.05$) was obtained in the birds fed the control diet. Feed/ gain ratio during the starter phase was significantly ($P < 0.05$) affected among different means. Birds that were maintained on 50% FFSB + 50% RSB + 6 g/kg yeast had better ($P < 0.05$) feed/ gain ratio than those on 100% Raw Soya Bean (RSB), 100% RSB + 12 g/kg yeast, and 100% RSB + 18 g/kg yeast. But the birds fed the other dietary treatments had similar ($P > 0.05$) feed/ gain ratio with those fed 50% FFSB + 50% RSB + 6 g/kg yeast.

In the finisher phase, the final body weights of the broilers which received dietary treatments of 75% FFSB + 25% RSB and 75% FFSB + 25% RSB + 12 g/kg yeast were similar ($P > 0.05$) with those of the control diet (100% FFSB) The birds that were fed dietary treatments group of 100% RSB + 12 g/kg yeast and 100% RSB + 18 g/kg yeast were similar in their final body weight, but were significantly ($P < 0.05$) lower than those of the birds fed dietary treatments containing 75% FFSB + 25% RSB + 6 g/kg yeast, 75% FFSB + 25% RSB + 8 g/kg yeast, and 25% FFSB + 75% RSB + 6 g/kg yeast. Mean weight gains of the broilers did not follow the same pattern as the final body weights of the birds during the finisher phase. Also, the average daily weight gains were affected ($P < 0.05$) by variations in dietary RSB levels. Birds fed dietary treatment with 25% RSB + 18 g yeast inclusion had the highest mean weight gain (1330.00 g/bird) which varied significantly ($P < 0.05$) with that of birds fed dietary treatments containing 100% RSB, 50% FFSB + 50% RSB + 18 g/kg yeast, 100% RSB + 12 g/kg yeast and 100% RSB + 18 g/kg yeast. Data on feed intake from the finisher phase also indicated significant ($P < 0.05$) differences among treatment means. Broilers that received dietary treatment containing 75% FFSB + 25% RSB + 8 g/kg yeast had highest ($P < 0.05$) feed intake compared favourably to those fed dietary treatments 75% FFSB + 25% RSB, 50% FFSB + 50% RSB + 18 g/kg yeast, 25% FFSB + 75% RSB + 12 g/kg yeast, and 100% RSB + 18 g/ kg yeast. The lowest feed intake was recorded by those in diet containing 100% RSB + 12 g/kg yeast which was significantly ($P < 0.05$) different from treatments groups with 75% FFSB + 25% RSB + 6 g/kg yeast, 75% FFSB +

Table 4: *Performance characteristics of broilers fed the finisher diets*
Preglednica 4: *Rezultati pitanja brojlerjev s finišerjem*

Treatments	Initial body wt. (g/bird)	Final body wt. (g/bird)	Wt. gain (g/bird)	Av. daily gain (g/bird/day)	Feed intake (g/bird/day)	Feed : gain ratio	Mortality (%)
T1	525.00^{abcd}	1685.00^{abcd}	1160.00^{abc}	41.43^{abc}	143.00^{abcd}	3.45^{bcd}	0.00
T2	450.00^{d}	1365.00^{cdc}	915.00^{bcd}	32.68^{bcd}	134.96^{abcd}	4.13^{a}	0.00
T3	570.00^{abc}	1635.00^{abcd}	1065.00^{abcd}	38.04^{abcd}	119.44^{bcd}	3.14^{d}	0.00
T4	585.00^{ab}	1800.00^{a}	1215.00^{abc}	43.40^{abc}	155.00^{abc}	3.57^{abcd}	0.00
T5	590.00^{a}	1650.00^{abcd}	1060.00^{abcd}	37.86^{abcd}	153.58^{abc}	3.40^{abcd}	0.00
T6	520.00^{abcd}	1850.00^{a}	1330.00^{a}	47.50^{a}	183.00^{a}	4.05^{ab}	0.00
T7	585.00^{ab}	1705.00^{abc}	1120.00^{abcd}	40.00^{abcd}	165.00^{ab}	3.87^{abc}	0.00
T8	525.00^{abcd}	1535.00^{abcde}	1010.00^{abcd}	36.08^{abcd}	150.12^{abcd}	4.17^{a}	0.00
T9	500.00^{abcd}	1310.00^{dc}	810.00^{cd}	28.93^{cd}	121.50^{bcd}	4.21^{a}	0.00
T10	520.00^{abcd}	1765.00^{ab}	1245.00^{ab}	44.47^{ab}	148.50^{abcd}	3.38^{cd}	0.00
T11	465.00^{cd}	1415.00^{bcde}	950.00^{abcd}	33.93^{abcd}	106.89^{cd}	3.15^{d}	0.00
T12	475.00^{bcd}	1520.00^{abcde}	1045.00^{abcd}	37.32^{abcd}	151.00^{abcd}	4.08^{ab}	0.00
T13	510.00^{abcd}	1540.00^{abcde}	1030.00^{abcd}	36.79^{abcd}	132.00^{abcd}	3.59^{abcd}	0.00
T14	460.00^{cd}	1210.00^{e}	750.00^{d}	26.79^{d}	97.54^{d}	3.65^{abcd}	0.00
T15	475.00^{bcd}	1330.00^{cde}	855.00^{bcd}	30.54^{bcd}	122.58^{bcd}	3.99^{abc}	0.00
SEM	10.51	61.55	36.61	1.30	5.02	0.08	0.00

a,b,c; means with the same superscripts within each column, are not significantly (P > 0.05) different; SEM = Standard error of the means

25% RSB + 12 g/kg yeast, 75% FFSB + 25% RSB + 8 g/kg yeast and 50% FFSB + 50% RSB + 6 g/kg yeast. The feed/ gain ratio during the finisher phase was significantly (P < 0.05) affected among treatment means. Birds fed dietary treatments 100% FFSB, 75% FFSB + 25% RSB, 25% FFSB + 75% RSB + 6 g/kg yeast and 25% FFSB + 75% RSB + 12 g/kg yeast had better (P < 0.05) feed: gain ratio than birds fed dietary treatments 100% RSB, 50% FFSB + 50% RSB + 12 g/kg yeast and 50% FFSB + 50% RSB + 18 g/kg yeast.

Results obtained for the entire production period (0–56 days) recorded similar trends in the final body weight, weight gain and average daily gain of birds fed the various dietary treatments. Those on 75% FFSB + 25% RSB + 6 g/kg yeast and 75% FFSB + 25% RSB + 8 g/kg yeast maintained highest values in the above mentioned parameters and varied significantly (P < 0.05) from those of birds fed dietary treatment 100% RSB, 50% FFSB + 50% RSB + 18 g/kg yeast, 25% FFSB + 75% RSB + 12 g/kg yeast, 100% RSB + 12 g/kg yeast and 100% RSB + 18 g/kg yeast. Data on feed intake from the overall production period also showed significant (P < 0.05) differences among means. Birds that were fed dietary treatment with 75% FFSB + 25% RSB + 8 g/kg yeast had the highest feed intake value which differed significantly (P < 0.05) from values recorded in birds which received dietary treatments having 75% FFSB + 25% RSB, 50% FFSB + 50% RSB + 18 g/kg yeast, 25% FFSB + 75% RSB + 12 g/kg yeast, 100% RSB + 12 g/kg yeast and 100% RSB + 18 g/kg yeast. Birds that were fed dietary treatment containing 100% RSB + 12 g/kg yeast had the lowest feed intake value (69.02 g/bird/day). The feed/ gain ratio for the entire production period exhibited significant (P < 0.05) differences among treatment means. Birds on dietary treatments 100% FFSB, 75% FFSB + 25% RSB, 75% FFSB + 25% RSB + 6 g/kg yeast, 25% FFSB + 75% RSB + 6 g/kg yeast, 25% FFSB + 75% RSB + 12 g/kg yeast, 100% RSB + 6 g/kg yeast and 100% RSB + 12 g/kg yeast had better (P < 0.05) feed/ gain ratio values than birds fed dietary treatments containing 100% Raw Soya Bean (RSB), 75% FFSB + 25% RSB + 12 g/kg yeast, 75% FFSB + 25% RSB + 8 g/kg yeast, 50% FFSB + 50% RSB + 6 g/kg yeast, 50% FFSB + 50% RSB + 12 g/kg yeast, 50% FFSB + 50% RSB + 18 g/kg yeast, 25% FFSB + 75% RSB + 18 g/kg yeast and 100% RSB + 18 g/kg yeast.

Bird mortality was only recorded during the starter phase (0–28 days). With the exception of broilers for dietary treatment 75% FFSB + 25% RSB + 12 g/kg yeast, there was no significant (P > 0.05) difference in the mortality recorded among the other birds fed the various dietary treatment diets.

***Table 5:** Overall (0–56 days) performance characteristics of broilers fed the experimental starter and finisher diets*
***Preglednica 5:** Proizvodni rezultati brojlerjev za celotno obdobje (0–56 dni), krmljenih s štarterjem in finišerjem*

Treatments	Initial body wt. (g/bird)	Final body wt. (g/bird)	Wt. gain (g/bird)	Av. daily gain (g/bird/day)	Feed intake (g/bird/day)	Feed / gain ratio	Mortality (%)
T1	35.50^{cd}	1685.00^{abcd}	1649.50^{abcd}	29.46^{abcd}	89.00^{abcd}	3.02^{cde}	0.170^{a}
T2	36.50^{bcd}	1365.00^{cde}	1328.00^{cde}	23.73^{cde}	87.50^{abcd}	3.69^{a}	0.020^{ab}
T3	37.00^{bc}	1635.00^{abcd}	1598.00^{abcd}	28.54^{abcd}	80.00^{bcd}	2.79^{e}	0.015^{b}
T4	35.75^{bcd}	1800.00^{a}	1764.00^{a}	31.51^{a}	98.00^{abc}	3.11^{bcde}	0.015^{b}
T5	39.50^{a}	1650.00^{abcd}	1614.10^{abcd}	28.82^{abcd}	98.04^{abc}	3.40^{abcd}	0.000^{b}
T6	35.00^{d}	1850.00^{a}	1810.50^{a}	32.33^{a}	110.00^{a}	3.41^{abcd}	0.110^{ab}
T7	35.50^{cd}	1705.00^{abc}	1669.75^{abc}	29.82^{abc}	102.00^{ab}	3.41^{abcd}	0.070^{ab}
T8	35.15^{cd}	1535.00^{abcde}	1499.50^{abcde}	26.78^{abcde}	95.56^{abcd}	3.60^{ab}	0.065^{ab}
T9	37.50^{b}	1310.00^{de}	1274.85^{de}	22.77^{de}	80.25^{bcd}	3.53^{abc}	0.105^{ab}
T10	36.00^{bcd}	1765.00^{ab}	1727.50^{ab}	30.85^{ab}	94.25^{abcd}	3.07^{bcde}	0.070^{ab}
T11	35.25^{cd}	1415.00^{bcde}	1379.00^{bcde}	24.63^{bcde}	72.70^{cd}	2.96^{de}	0.105^{ab}
T12	36.50^{bcd}	1520.00^{abcde}	1484.75^{abcde}	26.51^{abcde}	93.75^{abcd}	3.55^{abc}	0.110^{ab}
T13	36.50^{bcd}	1540.00^{abcde}	1503.50^{abcde}	26.85^{abcde}	86.50^{abcd}	3.23^{abcde}	0.110^{ab}
T14	37.50^{b}	1210.00^{e}	1172.50^{e}	20.94^{e}	69.02^{d}	3.29^{abcde}	0.115^{ab}
T15	39.50^{a}	1330.00^{cde}	1290.50^{cde}	23.05^{de}	82.54^{bcd}	3.56^{ab}	0.100^{ab}
SEM	0.28	40.62	40.62	0.73	2.46	0.06	0.01

a b c d e – means with the same superscripts within each column are not significantly different (P > 0.05); SEM = Standard error of the means.

3.2 NUTRIENT DIGESTIBILITY AND RETENTION

The results of the metabolism trial of the effect of the dietary treatment on the nutrient digestibility and retention are presented in Table 6. Nitrogen retention in the broiler fed dietary treatments 100% FFSB, 100% RSB and 75% FFSB + 25% RSB were significantly (P < 0.05) higher than that of birds fed dietary treatments containing 25% FFSB + 75% RSB + 18 g/kg yeast, 100% RSB + 6 g/kg yeast, 100% RSB + 12 g/kg yeast and 100% RSB + 18 g/kg yeast.

Fat retention in broilers fed treatments 75% FFSB + 25% RSB and 100% RSB + 6 g/kg yeast was significantly (P < 0.05) lower than those on treatments 75% FFSB + 25% RSB + 12 g/kg yeast and 50% FFSB + 50% RSB + 6 g/kg yeast which were also lower (P < 0.05) than others that were similar (P < 0.05). Crude fibre digestibility was higher (P > 0.05) among birds fed dietary treatments 100% FFSB, 100%RSB and 75% FFSB + 25% RSB than the birds fed diets 25% FFSB + 75% RSB + 6 g/kg yeast, 25% FFSB + 75% RSB + 12 g/kg yeast, 25% FFSB + 75% RSB + 18 g/kg yeast, 100% RSB + 6 g/kg yeast, 100% RSB + 12 g/kg yeast and 100% RSB + 18 g/kg yeast.

Dry matter digestibility varied significantly (P < 0.05) with birds fed the control diet having the highest value which differ significantly (P < 0.05) from other treatments. Birds fed dietary treatments 100% RSB and 75% FFSB + 25% RSB and 50% FFSB + 50% RSB + 12 g/kg yeast had similar (P > 0.05) dry matter digestibility which were higher (P < 0.05) than other treatments. Also, birds fed dietary treatment 75% FFSB + 25% RSB + 12 g/kg yeast had higher (P < 0.05) dry matter digestibility which were higher (P < 0.05) than those on 25% FFSB + 75% RSB + 6 g/kg yeast, 25% FFSB + 75% RSB + 12 g/kg yeast, 25% FFSB + 75% RSB + 18 g/kg yeast, 100% RSB + 6 g/kg yeast, 100% RSB + 12 g/kg yeast and 100% RSB + 18 g/kg yeast with100% RSB + 6 g/kg yeast having the lowest dry matter digestibility but was statistically similar (P > 0.05) to those on treatments 25% FFSB + 75% RSB + 6 g/kg yeast, 25% FFSB + 75% RSB + 12 g/kg yeast, 100% RSB + 12 g/kg yeast and 100% RSB + 18 g/kg yeast.

4 DISCUSSION

4.1 PERFORMANCE CHARACTERISTIC OF BROILERS FED THE EXPERIMENTAL DIETS

During the starter phase, differences in the mean final body weights, weight gains and average daily gains in chicks on the control diet (0% RSB) and those that received 100% RSB and combination of 75% FFSB and 25% RSB, all without yeast were significant (P < 0.05). However, the control birds were not significantly (P < 0.05)

Table 6: *Nutrient retention and digestibility of the broilers at 56 days of age*
Preglednica 6: *Retencija hranil in prebavljivost pri brojlerjih pri 56 dneh starosti*

Treatments	Nitrogen retention (%)	Fat retention (%)	Crude fibredigestibility (%)	Dry matter digestibility (%)
T1	68.25[a]	90.20[a]	85.40[a]	88,20[a]
T2	67.80[a]	70.01[ab]	85.20[a]	80.40[b]
T3	67.95[a]	74.20[c]	85.30[a]	80.50[b]
T4	67.30[ab]	88.07[a]	84.80[ab]	79.41[bc]
T5	67.45[ab]	81.50[b]	84.50[ab]	78.10[c]
T6	67.50[ab]	92.30[a]	84.70[ab]	79.00[bc]
T7	65.78[abc]	82.42[b]	84.40[ab]	79.36[bc]
T8	65.32[abc]	88.01[a]	83.40[ab]	80.25[b]
T9	65.39[abc]	90.30[a]	83.50[ab]	80.00[bc]
T10	61.09[abc]	88.40[a]	82.72[b]	75.10[de]
T11	61.20[abc]	89.80[a]	82.82[b]	75.20[de]
T12	59.41[bc]	87.20[a]	82.85[b]	75.50[d]
T13	59.48[bc]	74.50[c]	80.45[c]	73.50[e]
T14	58.21[c]	88.30[a]	80.61[c]	74.40[de]
T15	57.98[c]	89.10[a]	80.72[c]	73.60[de]
SEM	0.84	1.09	0.33	0.69

a b c d e; means with the same superscripts within each column, are not significantly (P > 0.05) different; SEM = Standard error of the means.

superior in average daily gains to those that received 25% RSB, 50% RSB, 75% RSB and 100% RSB all with yeast inclusion. This is an indication that broiler chicks can tolerate all levels of RSB with yeast inclusion in their diets. The mean final body weights of the broilers at the end of the finisher phase were significantly (P < 0.05) higher for birds which were fed 25% RSB, with 6 g/kg and 18 g/kg yeast inclusions than for birds that received diets with 50%, 75% and 100% RSB with yeast. Variations in mean body weight gains were unaffected (P > 0.05) by variations in dietary RSB levels, thus indicating that as the broilers grew older, they were better able to tolerate more of the test ingredient treated with yeast in their diets. Results on body weight gains for the overall production period (0–56 days), however, showed that gains were significantly (P < 0.05) depressed in the broilers when the level of RSB inclusion in their diets exceeded 75%. This suggests that incorporation of RSB into broiler rations should generally not exceed 75%.

The feed intake was not significantly (P > 0.05) influenced by variations in dietary RSB levels during the starter and finisher phases. At the starter phase, the feed intake was highest in broilers fed 25% RSB with 12 g/kg yeast inclusion and 100% RSB with 18 g/kg yeast, of which the latter has the highest feed : gain ratio. This pattern was not so with the finisher phase, where the highest feed intake was recorded in broilers fed 25% RSB with 18 g/kg feed yeast inclusion while the highest feed: gain ratio was found in birds fed 50% RSB with 18 g/kg feed yeast inclusion. This is in consonance with the suggestion above that the incorporation of RSB into broiler rations should not exceed 75%.

Mortality in the broilers occurred only during the starter phase, with chicks that received 100% dietary RSB with 6 g/kg yeast having the highest mortality 0.115%. Incidentally, very low mortality was recorded among chicks fed 100% dietary RSB without yeast inclusion. This is contrary to the numerous reports of the deleterious effect of raw soya bean on birds (D'Mello, 1982; Esonu *et al.,* 1997). Hence this very low mortality recorded in this study indicates that the use of raw soya bean as a feed ingredient in broiler rations is not lethal as to challenge the survival of broiler, but might negatively affect their general performance. Since there was no definite trend in mortality in line with variations in dietary RSB, the low mortality obtained point to the observation that RSB is not lethal to broilers.

4.2 NUTRIENT RETENTION AND DIGESTIBILITY

The decrease in nitrogen retention, and dry matter digestibility, crude fibre digestibility as the level of the test ingredient in the broiler diet was increased, showed the superiority of the control diet over other treatment diets. This therefore, implies that the birds on control diet had better nitrogen retention as well as better crude fibre and dry matter digestibility. Similar findings were reported by Akpodiete and Okagbare (2005), Akpodiete *et al.* (2004) and Ajaja (2005). However, the similarity between the birds on the control diet, and those on 50% dietary RSB in the proportion of nitrogen and fat retained, and in the amount of crude fibre digested suggested that up to 50% raw soya bean with yeast inclusion may be incorporated into broiler diets without deleterious effects on nitrogen and fat retention, and on crude fibre digestibility. For the dry matter digestibility, there was much dissimilarity in the birds among treatment groups with the birds on the control diet having the highest value. Within the treatment means, there was no trend in the dry matter digestibility values recorded.

5 SUMMARY AND CONCLUSION

The investigation on the effects of replacing FFSB with RSB in broiler diets at the starter (0–28 days) and finisher (0–29 days) phases revealed the following:

- At starter phase, mean final body weights, weight gains and average daily gains were similar for all the birds irrespective of the experimental diet fed, indicating that broiler starters can tolerate up to 100% of the test ingredient (with and without yeast) in their diets.
- Feed intake during the starter phase was affected by variations in the level of dietary RSB. Lower feed intake recorded by birds in 100% FFSB diet could as a result of increase in fat content of the diet.
- Uniformity in mortality record across the board implies the safety of the test ingredient as a potential poultry feed ingredient, with or without yeast inclusion.

Based on the overall production period (0–56 days), the study recommends feeding of 75% FFSB + 25% RSB + 8 g/kg yeast for optimal broiler production. Furthermore, the study demonstrated that farmers may replace FFSB up to 75% with RSB, both at the starter and finisher phases, without any deleterious effect on growth of the chickens.

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