Usage of brewer's yeast (*Saccharomyces cerevisiae*) as a replacement of vitamin and trace mineral premix in broiler diets

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SUMMARY

The effects of brewer's yeast (*Saccharomyces cerevisiae*) as a substitute for vitamin and trace mineral premix in broiler diets on some performance parameters and tibia ash proportions have been investigated. For that, 400 one-day old male broiler Ross-308 chickens were assigned to 5 equal treatment groups (allotted in 4 pens of 20 birds): a group was fed with diets containing recommended vitamin and trace mineral contents during the starting, growing and finishing periods and served as a positive control group, and the birds from the other 4 groups received diets depleted in vitamins and trace minerals by 75% supplemented by 0% (negative controls), 1, 3 and 5% brewer's yeast, respectively. Vitamin and mineral depletion has significantly decreased weight gains and food intakes determined for the growing and finishing periods and yeast addition whatever the dosage, has not prevented the negative effects on growth performance, particularly in the last period. The various dietary treatments have not significantly modified weights of visceral organs (gizzard, heart, spleen, liver and bursa of Fabricius) but abdominal fat deposits were markedly enhanced when 5% yeast was added to the vitamin / trace mineral depleted diets. Tibia ash amount was greatly diminished in birds fed with depleted rations and the bone effect was reversed in groups supplemented with 1% to 5% yeast. The results indicated that performance parameters were depressed by reduction of dietary vitamin and trace mineral content throughout the growing period independently of the yeast addition whereas the negative bone effects were prevented by the inclusion of yeast in broiler diets.

Key-words: Broilers, diets, dietary vitamin and trace mineral content, brewer's yeast, growth performance, tibia ash.

RESUME

Utilisation de la levure de bière (Saccharomyces cerevisiae) en remplacement d'un pré-mélange de vitamines et oligoéléments dans les rations alimentaires des poulets de chair.

Les effets de la levure de bière (*Saccharomyces cerevisiae*) en tant que substitut d'un mélange de vitamines et d'oligoéléments ajouté à la ration des poulets de chair sur la croissance et différentes caractéristiques des carcasses (poids des organes internes, proportions des cendres du tibia) ont été étudiés. Pour cela, 400 poussins Ross 308 de 1 jour ont été répartis en 5 groupes égaux (comprenant chacun 4 cages de 20 oiseaux) en fonction des régimes alimentaires mis en place : un des groupes a reçu des rations contenant les teneurs recommandées en vitamines et oligoéléments durant les phases de démarrage, de croissance et de finition et a servi de témoin positif alors que les autres ont été nourris par des rations appauvries de 75% en vitamines et oligoéléments supplémentées respectivement par 0% (témoin négatif), 1, 3 et 5% de levure de bière. La déplétion de la ration en vitamines et en oligoéléments a significativement diminué les gains de poids et les ingérés alimentaires déterminés pour les périodes de croissance et de finition et la supplémentation en levure quelque soit son dosage n'a pas prévenu les effets négatifs sur la croissance, particulièrement durant la dernière période. Aucun des différents régimes alimentaires n'a significativement modifié les poids des viscères (gésier, cœur, foie, rate et bourse de Fabricius) mais cependant, les dépôts de graisse abdominale ont été significativement accrus lorsque la ration appauvrie en vitamines et oligoéléments a été supplémentée par 5% de levure. La proportion des cendres osseuse (tibia) a significativement diminuée chez les oiseaux nourris par une ration appauvrie mais une supplémentation par 1% à 5% de levure a complètement annihilé cet effet. Ces résultats indiquent que la croissance des poulets est nettement ralentie par une réduction dans la ration des apports en vitamines et en oligoéléments durant toute la période de croissance indépendamment d'une supplémentation en levure alors que les effets négatifs sur l'os ont été contrecarrés par l'inclusion de levure dans la ration chez le poulet.

Mots-clés : Poulets, rations alimentaires, teneur de la ration en vitamines et oligoéléments, levure de bière, croissance, cendres du tibia.

Introduction

Some of the major issues faced by the poultry industry are about; improving efficiency of production, reducing environmental pollution resulted from litter and reducing food cost. In general, to meet these challenges, series of attempts have been made by researchers. Some of them are inclusion of food additives to improve growth performance, reduction of specific nutrient concentration or manipulation of nutrient utilization such as trace mineral nutrition to reduce food cost and nutrient excretion. The general consensus is that these nutrients may be omitted from the diet for various times of periods before slaughter without any significant effects on performance parameters and carcass traits [22-24].

WANG *et al.* [24] reported that trace mineral contents in broiler diets could be markedly reduced compared to current industry amounts without any adverse effects on live

Nutrients		Nutrients	
Crude protein (%)	44.35	Manganese (ppm)	15
Ether extract (%)	5.90	Sulphur (%)	0.50
Crude fibre (%)	4.80	Zinc (ppm)	90
Metabolisable energy (kcal/kg)	2800	Vitamin (mg/kg amino-acid)	
Crude ash (%)	4.70	B_1	18
Lysine (%)	3.30	B_2	40
Methionine (%)	0.90	Niacin	132
Calcium (%)	0.53	B_4	3300
Phosphorus (%)	1.38	B_5	518
Sodium (%)	0.16	B_6	34
Potassium (%)	0.06	B_{12}	0.44
Iron (ppm)	300	Biotin	2.2
Magnesium (%)	0.32	C	14.1

Table I: Chemical composition of brewer's yeast added to broiler diets at 1%, 3% or 5%.

performance and a reduction in supplemental trace mineral contents would be reflected in reduced trace mineral excretion. However, an experiment conducted to determine the removal of vitamin and/or trace mineral from broiler diet during the finisher period by DEYHIM and TEETER [5] showed that the removal of only vitamin or, both vitamin and trace mineral from the diet during 28 to 49 days reduced weight gain, food efficiency and breast yield. Removal of trace mineral alone was not detrimental. SHELTON and SOUTHERN [21] reported that growth performance was not affected in chicks fed with diets containing or not trace minerals but removal of the trace minerals had a negative effect on bone strength.

Brewer's yeast (*Saccharomyces cerevisiae*) has biologically valuable nutrients such as proteins, vitamin B-complexes, trace minerals and several other beneficial factors [20, 26] and yeast addition to animal foods has been known to improve the nutritive quality of food and performance of animals [9, 10, 27].

There is a lack of information on reduction of vitamin and trace mineral from broiler diet over all growth period and also on the effect of yeast addition on performance of broilers fed with diets poor in vitamins and trace minerals. Therefore, the objective of this study was to evaluate the influence of brewer's yeast (*Saccharomyces cerevisiae*) addition to diets with reduced vitamin and trace mineral contents throughout the growing period on performance parameters, processing characteristics and tibia ash of male broilers.

Materials and Methods

ANIMALS, EXPERIMENTAL DIETS, PROTOCOL DESIGN

Four hundred 1 day old male broiler Ross 308 chicks were obtained from a commercial hatchery. The experimental design was a completely randomized block design with five treatments, replicated four times each with 20 birds. Softwood shavings were used as litter material. Each pen contained one feeder and two nipple waterer. Temperature was controlled with electrically heater, maintained at 34°C for the first three days and then gradually reduced by 2-3°C per week to final temperature of 22°C. A 24 hour lighting program was provided.

Corn-soybean meal based broiler diets were formulated to meet the nutrient requirements (except vitamin and trace mineral) according to NRC [18] recommendations for starter (0-14 days), grower (14-35 days) and finisher (35-42 days) periods. The experimental basal diets consisted in 1) a positive control which included a commercial vitamin and trace mineral premix 100% of normal inclusion contents to meet or exceed vitamin and trace mineral requirements of NRC [18] recommendations and 2) a negative control which included vitamin and trace mineral premix at 25% of positive control diet. Broilers from the groups 1 and 2 were fed with the 2 respective positive and negative basal diets whereas those from the groups 3, 4 and 5 were fed with the negative control basal diets supplemented with 1, 3 and 5% brewer's yeast respectively. Chemical composition of brewer's yeast and composition and chemical analysis of experimental diets are shown in Tables I and II, respectively. The chemical analyses of yeast and diets were determined by recommendations of AOAC [2]. Vitamin and trace mineral contents in brewer's yeast were provided by supplier. Each diet with mash form and water were provided *ad libitum* consumption during 42 days of experimental period.

The experimental procedures used in this trial were approved by the University of Ankara Animal Care and Use Committee.

DATA COLLECTION

Body weight, weight gain, food intake and food conversion ratios were determined on days 14, 35 and 42. At the conclusion of the experiment, final weights were taken, and two broilers per pen were randomly selected to determine some processing characteristics. Another one bird per

	Starter (0-14 days)		Grower (15-34 days)		Finisher (35-42 days)	
	Positive diet	Negative diet	Positive diet	Negative diet	Positive diet	Negative diet
Foodstuffs (%)						
Corn	49.00	49.00	53.00	53.00	55.00	55.00
Soybean meal	34.05	34.20	29.80	29.95	25.35	25.50
Fullfat soybean	8.00	8.00	8.00	8.00	10.00	10.00
Meat / bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Vegetable oil	3.00	3.00	4.00	4.00	4.50	4.50
Dicalcium phosphate	1.10	1.10	0.70	0.70	1.00	1.00
Limestone	0.60	0.60	0.60	0.60	0.50	0.50
DL methionine	0.35	0.35	0.25	0.25	0.15	0.15
Lysine	0.20	0.20	0.10	0.10	0.00	0.00
Threonine	0.20	0.20	0.10	0.10	0.05	0.05
Salt	0.30	0.30	0.25	0.25	0.25	0.25
Vitamin premix[1]	0.100	0.025	0.100	0.025	0.100	0.025
Mineral premix[2]	0.100	0.025	0.100	0.025	0.100	0.025
Chemical analysis						
Dry matter (%)	93.78	93.78	93.13	93.10	92.98	93.08
Ash (%)	6.35	6.35	6.47	6.44	6.36	6.27
Crude protein (%)	23.20	23.20	21.08	21.05	19.40	19.32
Ether extract (%)	6.79	6.79	7.95	7.97	8.90	9.00
Crude fibre (%)	3.04	3.04	3.96	3.98	3.24	3.25
Metabolisable energy (kcal/kg)	3069	3069	3139	3133	3210	3210

[1]Vitamin premix: Each kg contains; 15 000.000 IU vitamin A, 5 000.000 IU vitamin D_3, 50 g vitamin E, 10 g vitamin K_3, 4 g vitamin B_1, 8 g vitamin B_2, 5 g vitamin B_6, 0.025 g vitamin B_{12}, 50 g niacin, 20 g pantothenic acid, 20 g folic acid, 0.25 g biotin, 75 g vitamin C. [2] Mineral premix: Each kg contains; 100 g Mn, 150 g Zn, 100 g Fe, 20 g Cu, 1.5 g I, 0.5 g Co, 0.2 g Se, 1 g Mo, 50 g Mg.

Table II: Composition and chemical composition of the positive and negative control diets distributed to broiler chickens for a 42 day long experimental period.

Parameters	Positive control (VMP 100%)	Negative control diet (VMP 25%) supplemented with brewer's diet				SEM	p
		0%	1%	3%	5%		
Weight gain (g)							
BWG_{1-14}	356.62	344.93	345.58	347.82	334.35	4.76	NS
BWG_{1-35}	1929.68[a]	1780.28[b]	1814.17[b]	1851.84[ab]	1798.88[b]	17.56	< 0.05
BWG_{1-42}	2558.32[a]	2346.76[b]	2345.09[b]	2366.97[b]	2341.27[b]	24.57	< 0.01
Food intake (g)							
FI_{1-14}	461.56	452.32	446.26	449.41	438.54	7.56	NS
FI_{1-35}	2910.63[a]	2757.73[b]	2757.85[b]	2829.47[ab]	2749.41[b]	20.54	< 0.05
FI_{1-42}	4088.91[a]	3852.89[b]	3827.59[b]	3923.23[b]	3874.47[b]	29.97	< 0.05
Food efficiency (g/g)							
FCR_{1-14}	1.30	1.33	1.29	1.29	1.31	0.01	NS
FCR_{1-35}	1.51	1.55	1.53	1.53	1.53	0.01	NS
FCR_{1-42}	1.60	1.64	1.63	1.66	1.65	0.01	NS

BWG_{1-i}: Cumulated body weight gain calculated for an i day long period from the first day of the experiment; FI_{1-i}: Cumulated food intake calculated for an i day long period from the first day of the experiment; FCR_{1-i}: Cumulated food conversion ratios (or food efficiency given by the ratio food intake / body weight) calculated for an i day long period from the first day of the experiment; NS: not significant.
Different superscripts a,b in the same row indicate significant differences ($p < 0.05$ or more) between groups.

Table III: Growth performances of broiler chickens according to the dietary treatments [positive control including a commercial vitamin and trace mineral premix (VMP), negative control including vitamin and trace mineral premix at 25% of positive control diet, and others: negative control diet supplemented with 1, 3 and 5% brewer's yeast, respectively] distributed for 42 days (n = 80 in each group allotted in 4 pens of 20 birds). Results are expressed as mean ± standard error of the mean (SEM).

Parameters	Positive control (VMP 100%)	Negative control diet (VMP 25%) supplemented with brewer's diet				SEM	p
		0%	1%	3%	5%		
Gizzard (g)	25.14	29.73	33.70	34.25	25.89	1.59	NS
Heart (g)	11.20	10.59	12.82	10.97	8.09	0.56	NS
Spleen (g)	2.96	2.61	3.32	3.25	2.66	0.11	NS
Liver (g)	40.13	41.39	42.35	43.99	39.76	0.81	NS
Bursa of Fabricius (g)	5.45	5.58	4.99	5.88	5.01	0.25	NS
Abdominal fat (g)	22.99[a]	21.88[a]	26.20[a]	28.07[a]	40.28[b]	1.82	< 0.05
Tibia ash (%)	42.72[a]	39.42[b]	41.99[a]	40.99[a]	43.08[a]	0.42	< 0.05

NS: not significant.
Different superscripts a,b in the same row indicate significant differences ($p < 0.05$) between groups.

Table IV: Visceral organ weights (g) and tibia ash levels (%) in broiler chickens according to the dietary treatments [positive control including a commercial vitamin and trace mineral premix (VMP), negative control including vitamin and trace mineral premix at 25% of positive control diet, and others: negative control diet supplemented with 1, 3 and 5% brewer's yeast, respectively] distributed for 42 days (n = 80 in each group allotted in 4 pens of 20 birds). Results are expressed as mean ± standard error of the mean (SEM).

pen was killed by cervical dislocation then the left tibia was removed for each animal, and ash content of dried, fat free bone was determined as described by AOAC [2].

STATISTICAL ANALYSIS

Statistical analyses were performed using the SPSS (version 10.0, USA) software package for Windows. Data on body weight, food intake, food conversion, visceral organ weights and tibia ash were analyzed by one-way ANOVA. Significant differences among the treatments were accepted at $p < 0.05$ and means were separated using Duncan's multiple range tests [6].

Results

In the experiment, body weight gains and food intakes were similar among the groups during the starting period (1-14 days of age). However, significant reductions in weight gains and food intakes were recorded in broilers fed with diets containing 25% of the normal supplemental content of vitamins and trace minerals containing or not brewer's yeast during the growing ($p < 0.05$) and the finishing ($p < 0.01$) periods. Nevertheless, differences during the growing period were not significant between the positive controls and the birds fed with the negative control diet supplemented with 3% yeast which exhibited intermediate weight gains and food intakes (Table III). Although food intake values were significantly different between the positive control group and the other ones, food conversion ratios did not show statistical differences at the end of the experiment because of reducing body weight.

Effects of reducing dietary vitamin and trace mineral contents with or without yeast addition on visceral organ weights are reported in Table IV. No statistically significant differences in weights of various organs (gizzard, heart, spleen, liver and bursa of Fabricius) were found among groups. On the other hand, the abdominal fat deposits were dramatically increased in birds receiving 5% of yeast added to the negative control diet compared to all the other groups ($p < 0.05$) whereas the dietary vitamin and trace mineral content has not significantly affected this parameter. Reducing the amount of vitamin and trace mineral in broiler diet significantly decreased the tibia ash in birds ($p < 0.05$), but simultaneous yeast addition whatever the dosage was significantly effective for improving tibia ash (Table IV).

Discussion

A few data have been reported on combined vitamin and trace mineral reduction or removal in broiler diets and almost all of them were conducted during finishing or growing plus finishing periods. Some reports [3, 13, 16, 22] indicated that removal of the trace mineral premix during the finishing period have not negatively impacted growth performance, bone variables, or processing characteristics in broilers. However, in this study, reduction of vitamin and trace mineral premix from diet up to 25% of normal inclusion content applied for the whole growth period has negatively affected weight growth, bringing out low weight gain.

In another experiment, DEHIYM and TEETER [5] reported that combined vitamin and trace mineral withdrawal between the 28th and the 49th days has significantly reduced weight gain and food efficiency in male broilers whereas vitamin or trace mineral removal alone had no significant effects. By contrast, SKINNER *et al.* [22] showed that removal of vitamin or/and trace mineral supplements from the diet during the 28 to 49 days had no significant effect on weight gain and food conversion in broilers. NILIPOUR *et al.* [16], in a study used mineral and vitamin premixes at 0, 25, 50, 75 and 100 % of recommended level, concluded that reduction of the premixes up to 50% have no adverse effect on broiler performance. CHRISTMAS *et al.* [3] showed that removing both mineral and vitamin premixes from broiler diets during last 2 weeks of growing period (weeks 4 and 5)

significantly reduced weight gain but their removing during only the last week has not adversely affected performance and they reported that it is possible to withdraw mineral and vitamin premixes from commercial broiler diets on the last week of the growing period. According to the suggestions, the need for vitamin and minerals may be more crucial at certain stages of the body development [25] because the deficiency in minerals and vitamins requires long periods to demonstrate clinical signs [11]. Recently, in a study conducted by EBRAHIMNEZHAD *et al.* [7] the effect of mineral premix removal from diet during different periods (starter, 1-21 days; grower, 22-42 days; finisher, 43-49 days, and all rearing periods) on the performance of broilers were examined. They reported that during the starter and grower periods weight gains among the treatment groups were similar, but in the finisher period, weight gains were significantly lowered ($p < 0.01$) when mineral premix has been removed for the starting and growing periods or for the all rearing periods. Their results also showed that among the experimental groups there were no differences in food intake, carcass, abdominal fat, liver, breast, leg and tibia bone ash.

When dietary yeast inclusion is evaluated in broilers, it is generally concluded that yeast addition improved performance parameters [8, 26]. But literature data evaluating combined yeast addition and vitamin or/and trace mineral withdrawal in broiler diets are scarce. Besides, the vitamin and trace mineral reduction was generally applied during the 1 or 2 last weeks before slaughter. These reports showed that the yeast addition to diets containing low amount of vitamin and trace mineral premix had positive effects on growth parameters in broilers [14, 17]. In the present study, the reduction of the amount of vitamin and trace mineral premix in the broiler diets during all the rearing periods has markedly negatively affected weight gain and food intake and yeast addition was not effective for improving performance parameters until the 42nd day of age.

In the present study, there was no effect of the reduction of vitamins and trace minerals up to 25% of normal inclusion dietary content on gizzard, heart, spleen, liver, abdominal fat and bursa of Fabricius weights in male broiler chickens. Similarly, few reports [7, 22] showed that reduction or withdrawal of vitamin and trace mineral premix did not change visceral organ weights. On the other hand, abdominal fat weight was increased by 5% of yeast addition compared to the other groups. This result was partially in disagreement with some other studies which evidenced some beneficial effects of yeast addition on carcass characteristics and organ yields [12, 19]. PARYAD and MAHMOUDI [19] reported that dietary *Saccharomyces cerevisiae* addition could improve the performance, blood constituents and carcass characteristics of broiler chickens. Generally, in the studies with low level (1 or 2%) of yeast addition, abdominal fat weight was decreased [19] or not changed [5] whereas the abdominal fat weight was considerably increased with 5% dietary yeast inclusion to vitamin / mineral depleted diets in the present study. This observation might be related to that high level of dietary yeast inclusion change the fatty acid and/or amino acid profile of diets and hence, this alteration brought higher lipid storage in adipose tissues and increased the abdominal fat weights of broiler chickens.

On the other hand, reducing dietary vitamin and trace mineral amounts had a negative effect on tibia ash whereas the 1% to 5% yeast addition has counteracted the deleterious bone effect. Similarly to present study, AKHAVAN-SALAMAT *et al.* [1] found out that dietary yeast addition significantly increased the tibia ash level compared to the control group. They assumed that the increase in tibia ash percentages may be related to improvement of the mineral utilisation in broilers. Indeed, as *Saccharomyces cerevisiae* yeast is rich in proteins, vitamin B-complexes and trace minerals, it may increase phosphorus availability [4, 15].

As a conclusion, weight gain and food intake at the end of the growth period (42 days of age) were adversely affected by a reduction of vitamin and trace mineral premix up to 25% of the normal supplemental level and the dietary yeast addition has not efficiently improved growth performance. Nevertheless, the negative effect of the dietary reduction of vitamins and trace minerals on tibia ash was completely reversed by the yeast addition. In further studies, the effects of different percentages of dietary vitamin and mineral reduction at various growth periods combined to the yeast supplementation should be investigated.

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