Evaluation of torula yeast (*Candida utilis*) grown on distillery vinasse for broilers

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The inclusion of torula yeast (*Candida utilis*) grown on distillery vinasse as alternative protein source in the diet was evaluated. Its effect was determined on the productive performance and carcass yield of broilers. Animals were housed in metallic cages (1000 birds, from 1 to 42 d of age), according to a completely randomized design. The experimental treatments consisted of a control diet (maize-soybean) and three diets including 10, 20 and 30% of vinasse torula yeast, with ten replications each. Feed consumption showed an increase ($P < 0.001$) with the inclusion of yeast being more marked with 20 and 30%, which influenced negatively on feed conversion, while 10% did not differ from the control and allowed the highest ($P < 0.001$) live weight gain (1 830 g vs. 1 803). Live weight and carcass yield with 30% torula yeast was lower ($P < 0.01$) than with 10%, although not differing from the control group and that of 20%. It is considered that up to 20% of vinasse torula yeast can be used in diets for broilers, as partial replacement of soybean cake meal, without affecting the productive performance and carcass yield.

Key words: *broilers, yeast, protein source, alternative feeds, distillery vinasse*

In the formulation of poultry rations, protein sources represent approximately 25% of the feeding cost, value that can change in function of the amino acid balance and other nutrients (Ost *et al*. 2007). Soybean cake containing from 44 to 46% of crude protein (CP), is the protein source which is traditionally used in balanced feeds for broiler feeding (Gerber *et al*. 2006). In countries like Cuba that are not great producers of this oleaginous, is a challenge the search for alternatives allowing to replace, partially or totally, this feeding source. In addition to this limitation, there is the present tendency of using grains (maize, wheat and others) for ethanol production, the same as the oleaginous for producing biodiesel, conditions favoring the increase in the price of foods in the international market (FAO 2010).

Yeasts are successfully used in poultry feeding in partial substitution of the traditional protein source (Valdivié *et al*. 1977, Maia *et al*. 2001 and Perdomo *et al*. 2004). During several decades, in Cuba torula yeast was employed due to its high contribution of amino acids, vitamins and minerals (Valdivié *et al*. 1982 and Morales *et al*. 2000). However, the composition of this product could vary when changes in the production technology are introduced being thus necessary facing this new context to determine its nutritive value (Álvarez *et al*. 1981).

Saura *et al*. (2008) proposed to obtain torula yeast with the use of distillery vinasse as substrate for mitigating environmental the pollution generated by this residual. Studies conducted with this new protein source showed variations in its nutritive value (Llanes *et al*. 2009, Ortiz *et al*. 2011 and Rodríguez *et al*. 2011). The objective of this study was to assess the inclusion of torula yeast obtained from distillery's vinasse as substrate basis, as alternative protein source in the diet and to determine its effect on the productive performance and carcass yield of broilers.

Materials and Methods

One thousand one day old and of both sexes Cornish x White Plymouth Rock broilers, from the hybrid HE21 were used. They were randomly placed in 1 m^2 cages, at a rate of 25 chickens per cage until 14 d of age and 12 chickens per battery from 14 to 42 d of age. Water and feed were supplied *ad libitum*. Also, there was 24 h of illumination.

A three phase feeding system was applied: starter from 1 to 21 d, growth from 22 to 35 d, finish or finalization from, 36 to 42 d. Diets utilized were in meal form and they were formulated isoproteic and isocaloric, according to the recommendations of UECAN (2007). Broilers were conveniently vaccinated, according to the scheme established by the National Institute of Veterinary Medicine (IMV) against smallpox, infectious bronchitis, Newcastle and Gumboro.

Treatments consisted of a maize-soybean control diet and three diets including 10, 20 and 30 % of vinasse torula yeast, with ten replications in each treatment. Tables 1, 2 and 3 show the composition and contribution of the diets for each feeding stage.

For determining animal performance, weekly feed consumption, daily mortality and live weight at the beginning and end of the rearing (42 d) were controlled. From these records, feed conversion and live weight gain were calculated. As health indicator the viability of birds was considered.

At the end of the experimental period (42 d) 12 broilers were selected (6 females and 6 males), from the average live weight of the birds of each treatment. They were identified with an enumerated loop around

Table 1. Composition and contribution of the starter diets (1 to 21 d of age) in humid basis

Ingredients, %	Vinasse torula yeast, %			
	0	10	20	30
Maize meal	46.57	48.00	49.35	50.98
Soybean cake meal	41.65	31.63	21.73	11.79
Vegetable oil	6.65	5.50	4.40	3.08
Vinasse torula yeast	0.00	10.00	20.00	30.00
Common salt	0.35	0.35	0.31	0.31
L-lysine	0.03	0.00	0.00	0.00
DL-methionine	0.25	0.22	0.21	0.20
Monocalcic phosphate	1.80	1.40	1.00	0.60
Calcium carbonate	1.56	1.76	1.86	1.90
Choline chloride	0.14	0.14	0.14	0.14
Vitamin and mineral premix[1]	1.00	1.00	1.00	1.00
Calculated contribution, %				
ME, MJ/kg	12.97	12.97	12.97	12.97
Crude protein	22.00	22.00	22.00	22.00
Calcium	1.03	1.05	1.05	1.04
Available phosphorus	0.50	0.50	0.50	0.50
Methionine + cystine	0.95	0.950	0.950	0.95
Lysine	1.38	1.45	1.54	1.64

[1]Each kg contains: vitamin A, 13 500 IU; vitamin D3, 3 375 IU; Vitamin E, 34 mg; B2, 6 mg; pantothenic acid, 16 mg; nicotinic acid, 56 mg; Cu, 20 mg; folic acid, 1.13 mg; vitamin B12, 34 µg; Mn, 72 mg; Zn, 48 mg.

Table 2. Composition and contribution of growing diets (22 to 35 d of age) in humid basis

Ingredients, %	Vinasse torula yeast, %			
	0	10	20	30
Maize meal	52.67	54.27	55.81	57.23
Soybean cake meal	36.00	26.00	16.00	5.910
Vegetable oil	6.35	5.10	3.86	2.70
Vinasse torula yeast	0.00	10.00	20.00	30.00
Common salt	0.35	0.35	0.32	0.32
L-lysine	0.19	0.18	0.16	0.15
DL-methionine	1.58	1.16	0.78	0.60
Monocalcic phosphate	1.72	1.80	1.93	1.95
Calcium carbonate	0.14	0.14	0.14	0.14
Choline chloride	1.00	1.00	1.00	1.00
Vitamin and mineral premix[1]	1.00	1.00	1.00	1.00
Calculated contribution, %				
ME, MJ/kg	13.18	13.18	13.18	13.18
Crude protein	20.00	20.00	20.00	20.00
Calcium	1.03	1.01	1.01	1.02
Available phosphorus	0.45	0.45	0.45	0.45
Methionine + cystine	0.85	0.85	0.85	0.85
Lysine	1.20	1.30	1.40	1.49

[1]Each kg contains: vitamin A, 13 500 IU; vitamin D3, 3 375 IU; Vitamin E, 34 mg; B2, 6 mg; pantothenic acid, 16 mg; nicotinic acid, 56 mg; Cu, 20 mg; folic acid, 1.13 mg; vitamin B12, 34 µg; Mn, 72 mg; Zn, 48 mg.

Table 3. Composition and contribution of the finishing diets (36 to 42 d of age) in humid basis

Ingredients, %	Vinasse torula yeast, %			
	0	10	20	30
Maize meal	58.83	60.50	62.35	65.00
Soybean cake meal	30.50	20.31	10.17	0.000
Vegetable oil	5.95	4.75	3.40	1.21
Vinasse torula yeast	0.00	10.00	20.00	30.00
Common salt	0.35	0.35	0.33	0.31
L-lysine	0.18	0.17	0.16	0.14
DL-methionine	1.60	1.20	0.80	0.40
Monocalcic phosphate	1.45	1.58	1.67	1.80
Calcium carbonate	0.14	0.14	0.14	0.14
Choline chloride	1.00	1.00	1.00	1.00
Vitamin and mineral premix[1]	1.00	1.00	1.00	1.00
Calculated contribution, %				
ME, MJ/kg	13.38	13.38	13.38	13.38
Crude protein	18.00	18.00	18.00	18.00
Calcium	0.92	0.92	0.91	0.91
Available phosphorus	0.45	0.45	0.45	0.45
Methionine + cystine	0.79	0.79	0.79	0.79
Lysine	1.06	1.15	1.25	1.34

[1]Each kg contains: vitamin A, 13 500 IU; vitamin D3, 3 375 IU; Vitamin E, 34 mg; B2, 6 mg; pantothenic acid, 16 mg; nicotinic acid, 56 mg; Cu, 20 mg; folic acid, 1.13 mg; vitamin B12, 34 μg; Mn, 72 mg; Zn, 48 mg.

the right foot. Animals were individually weighed and placed in cages, without access to water and feed for 12 h prior to slaughter.

Birds were slaughter, according to Sánchez (1990), through a cut in the carotid artery and the jugular vein and they were bled in two minutes. Later, they were scalded, plucked and eviscerated, manually. Once eviscerated, carcass weight without edible viscera (heart, liver and gizzard) and excessive abdominal fat was recorded. Carcasses were divided by the different parts (breast, legs + thighs, neck and edible viscera) and weighed.

Data were processed by variance analysis, according to a completely randomized design. Before applying ANAVA, data normality was verified by Shapiro Wilk test. For the homogeneity of the variance Bartlett test was applied. In the necessary cases Duncan's (1955) multiple range test was used for determining differences between means. The viability variable was transformed by the arc sinus √%, since it did not comply with the suppositions of the analysis of variance. The transformation improved the performance of such suppositions. The statistical package INFOSTAT, version 1.0 (Balzarini *et al.* 2001) was used.

Results and Discussion

The productive performance of broilers is shown in table 4. Feed consumption increased with the inclusion of vinasse torula yeast being more marked with 20 and 30 % of inclusion. These results coincide with those obtained by Longo *et al.* (2005) who included yeast (*Saccharomyces sp.*) in broiler diet. These authors reported an increase of feed consumption which affected in turn feed conversion.

According to Rodríguez *et al.* (2011), the effect found on feed consumption could be determined by the low nutrient retention with the utilization of the yeast (56 %) under study, the same as in others. In that regard, Ward and Marquardt (1987) and Ferket (1996) recognized the components of the cell wall of yeasts as anti-nutritional factors, since the enzymatic action of the gastrointestinal tract of the animals is almost nil on the cell wall and interfere or block the digestion and absorption of other nutrients. That is why the bird increases feed consumption to cover its nutrient requirement.

Butolo *et al.* (1997) found a quadratic effect on feed consumption and stated that yeast (*Saccharomyces cerevisae*) recovered from alcohol distilleries could be used until a level of 5 %. These results were associated to a low digestibility of the cell wall of yeasts, with the consequent reduction of nutrient availability and of the productive indicators on employing higher levels (10 and 15 %).

Table 4. Effect of vinasse torula yeast on the productive indicators of broilers at 42 d of age

Indicators	Vinasse torula yeast, %				SE ±
	0	10	20	30	
Total feed consumption, g/bird	3584.0[a]	3661.0[b]	3800[c]	3803[c]	15.0***
Live weight, g/bird	1898.0[b]	1933.0[c]	1897[b]	1726.0[a]	8.0***
Feed conversion, kg/kg	1.89.0[a]	1.89.0[a]	2.00b	2.20[c]	0.01***
Live weight gain, g	1803.0[b]	1830.0[c]	1801.0[b]	1630.0[a]	8.0***
General viability, %[1]	78.50 (95.64)	77.92 (95.20)	79.64 (96.44)	79.64 (96.82)	0.03

[1]Original means in parenthesis, [abc] Means with different letters in the row differ at P < 0.05 (Duncan, 1995) ***P < 0.001

With the inclusion of 20 and 30 % of vinasse torula yeast, feed conversion worsened in a proportional way to the increase of feed consumption, while with 10 % did not differ from the control. These results coincide with Latrille *et al*. (1976), who referred that in broiler diets feed conversion worsens when the yeast (*C. utilis*) level is 25 % or more. In the same way, on substituting the protein of the soybean meal by recovered yeast (*Saccharomyces sp.*), Oliveira *et al*. (1998) obtained up to 45 % finding a linear increase of feed conversion in broilers with the increase of substitution.

The inclusion of 10 % of vinasse torula yeast allowed the highest live weight gain; it was not affected with 20 % being lower with 30 % (table 4). However, Surdzhiiska *et al*. (1987) stated, regarding the control, a decrease between 5 and 10 % of live weight gain of birds, on including 20 % yeast. However, with the inclusion of 20 % of yeast, live weight gain and live weight of broilers was similar to the control group. This indicates the possibility of using until this level, without compromising animal performance. Results encountered in this study confirmed the arguments of different authors (Oguntona *et al*. 1986, Surdzhiiska *et al*. 1987 and Butolo *et al*. 1997) on the inhibiting effect of live weight with levels higher than 20 % of yeast.

The inclusion of 30 % of vinasse torula yeast allowed substituting totally the soybean meal. According to Rodríguez *et al*. (2011) the lowest response found in birds consuming these diets, could be related to lower nutrient retention of this protein source. Also, Tillán *et al*. (1986) found lower nitrogen retention when high levels of molasses torula yeast (27 %) were employed, that could be associated to an amino acid unbalance. Hence, torula yeast, regardless the substrate used for obtaining it, must be employed with other protein sources of greater digestibility allowing a balance in the nutrients contributed by the diet.

Viability of birds was not affected by the inclusion of vinasse torula yeast. This result coincides with Valdiviè (1976), Murakami *et al*. (1993) and Longo *et al*. (2005), who found no significant changes in this indicator with yeast inclusion. There were no differences in breast and total viscera yields either in weight and leg + thighs yields or in abdominal fat, with the utilization of vinasse torula yeast in the broiler diet (table 5). Results coincide with Miazzo *et al*. (2005 a,b), who did not observe changes in the quality parameters in the carcass of broilers fed yeast.

Weight and carcass yield of birds, with 30 % of vinasse torula yeast included in the diet, were lower than 10 % although did not differ from the control group and that receiving 20 %. In the same way performed breast

Table 5. Fresh weight and yield of edible portions and viscera of broilers fed different levels of torula yeast at 42 d of age

Indicators	Vinasse torula yeast, %				SE ±
	0	10	20	30	
Number of observations	12.0	12.0	12.0	12.0	
Carcass weight, g	1215.0[ab]	1258.0[b]	1237.0[b]	1135.0[a]	30.0**
Carcass yield, %	60.11[ab]	60.83[b]	59.22[ab]	58.58[b]	0.58*
Breast weight, g	336.0[ab]	345.0[b]	339.0[ab]	307.0[b]	12.0*
Breast yield, %	28.19	27.84	28.44	27.27	0.39
Legs + thighs weight, g	434.0	432.0	427.0	402.0	11.0
Legs + thighs yield, %	35.84	35.91	36.07	35.28	0.32
Excessive abdominal fat, g	31.58	28.42	31.67	26.00	2.21
Abdominal fat yield, %	2.61	2.12	2.60	2.50	0.17
Total viscera weight, g	193.0[ab]	197.0[ab]	204.0[b]	181.0[b]	5.0*
Total viscera yield, %	15.94	16.01	16.77	15.98	0.32

[ab]Means with different letters in the same row differ at P < 0.05 (Duncan 1955) *P < 0.05 **P < 0.01

and total viscera weights. This effect on the carcass could be due to lower live weights attained by broilers in this treatment (Leeson *et al*. 2000) or perhaps, to lower nutrient digestibility when yeast levels above 20 % are used.

Possibly, the increase in lysine consumption with the highest vinasse torula yeast (20 and 30 %), allowed a similar yield than the control group, regarding the carcass and to the different edible parts. However, Moreira *et al*. (1998), on including increasing yeast levels in rations for growing and finishing pigs, verified an increase of lysine consumption and did not confirm beneficial effects of this amino acid on performance and carcass characteristics.

This study demonstrated that torula yeast, grown on distillery vinasse as substrate basis, can be used in broiler feeding until 20 % as partial substitute of soybean cake meal, without affecting the productive performance and carcass yield.

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