

Nutritional Value of Spent Brewers' Yeast (*Saccharomyces cerevisiae*): A Potential Replacement for Soya Bean in Poultry Feed Formulation

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Abstract: Background: The increase in the world population results in a rising protein demand which becomes the most important factor in accelerating the development of the poultry industry. Poultry requires nutrients such as protein, fat, carbohydrate, vitamins and minerals for growth and development. Protein source within the poultry feed contributes to the major cost in the fish industry. Thus, an evaluation of single cell protein, the spent brewer's yeast (*Saccharomyces cerevisiae*) as a feed material was carried out to determine its potential application in poultry feed formulation. **Methods:** Spent brewers' yeast (*Saccharomyces cerevisiae*) was inactivated by boiling and then machine dried analysis analysed for nutritional value. **Results:** The crude protein was 40.52% dry basis with crude fibre of 4.31% also on dry basis. It had a metabolizable energy of 2606.07 kcal/kg. The amino acid analysis showed that both essential and non-essential amino acids were present. The essential amino acids included leucine (8.42%), valine (6.07%), threonine (5.65%), isoleucine (5.37%), phenylalanine (5.30%), arginine (4.74%), histidine (2.93%), lysine (2.93%) and tyrosine (2.73%). Non-essential amino acids included glutamic acid (14.98%), aspartic acid (11.98%), alanine (7.26%), serine (5.75%), proline (4.84%) and glycine (4.83%). Cystic acid, methionine and tryptophan were absent. **Conclusion:** These results showed that the spent brewers' yeast had nutritional value and can be used to formulate animal feeds such as poultry feeds as protein source to replace soya bean. However, methionine and tryptophan would have to be supplemented.

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Introduction

The search for alternative sources of local ingredients to produce good quality feeds in an ongoing research in Nigeria. This is because conventional ingredients for animal feeds such as soya beans and maize are also used by humans and this makes them expensive (Ref). Livestock production is a socio-economic activity that could lead to improved income and quality of living among the Nigerian populace. Of these, protein sources are the most expensive. In recent years, researchers have begun to pay attention to the private sector making policies relating to livestock production. Before now, the Nigerian economy depended mainly on traditional livestock for animal protein sources but this has proved to be insufficient.

The average protein intake as recommended by FAO (Ref) is 36g/day while it is 3.5g/day in Nigeria. In Nigeria, low animal protein intake has remained a non-wage nutritional problem especially for low

income and non-wage earners (Amefule and Obioha, 2005; Obun, 2007).

Continual dependence on conventional sources of animal feed ingredients may not be the solution to the problems facing the Nigerian Livestock industry. As production of feed ingredients such as grains and legumes by local farmers remain insufficient to meet human and animal feeding, the alternative is to employ unconventional ingredients such as spent brewers' yeast which do not have direct human value (Iyayi and Aderolu, 2004).

Spent brewers' yeast which is a by-product in the brewery and distillery industries and a good protein source, is usually dumped into the environment as a waste product. This increases the pollution of water bodies by increasing the biological oxygen demand (BOD). Spent yeast is cheap and can be obtained in areas where breweries are situated. The breweries will be willing to supply it to farmers since they regard it as a better and cheaper way of its disposal. Incorporating it in animal feeds will reduce the cost of

animal feeds especially poultry feeds which currently accounts for about 70% of total production cost of poultry. Cheaper feeds will translate to cheaper chicken for the consumer and increased profitability for farmers (Nilson *et al.*, 2004). This will go a long way in increasing animal protein intake for more Nigerians.

There is therefore an urgent need to develop dietary sources of cheap animal proteins to bridge the wide gap that exists between animal protein supply and consumption. Hence, this work assessed the nutritional value of spent brewers' yeast (*Saccharomyces cerevisiae*) as a potential replacement for soya bean in poultry feed formulation.

Materials and Methods

Collection of spent brewers' yeast

Dried brewers' yeast was purchased from Guinness Nigeria PLC, Lagos and transported on 25kg bag for the experiment. The yeast cells were confirmed to be dead through viability checks described by Zoehain *et al.* (1990).

Proximate analysis of spent brewers' yeast (*Saccharomyces cerevisiae*)

The following parameters were determined according to analysis of the Association of Official Analytical Chemists, AOAC, (2006).

Dry matter and ash determination

Two grains (2g) of the sample was oven dried at 105°C for 24 hours and reweighed. The weight loss was that of moisture and dry matter was calculated thus:

Percentage of dry matter (DM) = 100 - % moisture

$$\%N = \frac{14.01 \text{ml of titrant sample} - \frac{M}{\text{titrant}} \text{blank} \times \text{MOL of standard}}{\text{Sample} \times 10}$$

%CP = N x 6.25 (factor for feeds)

Determination of crude fat (ether extract)

This was carried out by refluxing in the soxhlet apparatus. Two gram (2g) of spent brewers' yeast was placed in a thimble and the mouth closed with a piece of cotton wool. The thimble was placed into a weighed extraction flask of 500ml size, containing 200ml petroleum ether. The two units were fixed onto a heating mantel and a condenser placed on top of the unit. The heating mantel was turned on at a temperature of 60°C. As the ether in the flask

The ash or total mineral content was determined by incinerating 10g of dried sample in a furnace at 600°C for 3 hours. After incineration, the ash was cooled in a desiccator and then weighed. The % ash for the sample was calculated.

$$\% \text{ ash} = \frac{\text{weight of residue}}{\text{weight of dried sample}} \times 100$$

Determination of crude protein (CP)

The determination of crude protein was done in 3 stages: digestion, distillation and titration. Two gram (2g) of a prepared sample was placed in a digestion tube and 2 digestion tables which served as catalysts added. Twenty five (25ml) of concentrated sulphuric acid added. The tube was placed in a digestion block covered with the exhaustion cap and switched on. Digestion was started at a low temperature to avoid rapid reaction, which would cause the sample to over boil. Digestion was continued for 2 hours. The digested sample was allowed to cool at room temperature and then diluted with distilled water to a volume of 100ml. distillation was carried out in a distillation machine. Fifty microliter (50 ml) of NaOH was added to the digested sample. The distillation machine has a provision for water that is heated to give steam. The steam passes through the digested sample + NaOH to carry over the NH₄OH that will be condensed into a receiver flask containing boric acid + indicator (bromocresol green + methyl red). The NH₄OH in boric acid changed the initial reddish colour of boric acid to green indicating the presence of a base (NH₃). After distillation, the NH₃ in boric acid was titrated with 0.1NHCl. Crude protein was then calculated as follows:

evaporated, it followed the side arm and got into the condenser of the soxhlet where it condensed and came down into the extraction chamber. As it dripped on the sample in the thimble, it extracted the fat and when the chamber was full, the siphon arm filled up also and when it could not go anymore, it followed the bench and poured down in the flask. As the process was repeated (refluxing), the whole fat in the sample was removed and received into the flask. After about 5 hours, the ether coming down was dried at 100°C for 1 hour, cooled in a desiccator and weighed. Ether extract was then calculated as follows:

$$EE\% = \frac{\text{weight of oil flask after extraction} - \text{weight of empty flask}}{\text{weight of dried sample}} \times 100$$

Crude fibre

The soxhlet apparatus was used to defat the sample and subsequently dried in the desiccator. About 200g of the sample was then weighed (W_1) into a 250 ml flat bottom quick fit flask. Crude fibre reagent (100ml) was added to the sample flask. A reflux condenser was fixed and the flask put on a heating mantel. The content was boiled for 45 minutes to 1 hour by refluxing and shaking of sample. It was then cooled and filtered using filter paper. It was further rinsed with hot distilled water. The residue was washed the filter paper into a crucible with hot distilled water. The content of the crucible was dried at 120 - 130°C and cooled in the desiccator and weighed (W_2). The crucible was then put in a muffle furnace at a temperature of 600°C for 6 hours. It was then cooled in a desiccator then weighed (W_3). Crude fibre was calculated as follows:

$$CF = \frac{W_2 - W_3}{W_1} \times 100$$

Nitrogen free extract

This represents the soluble protein in a sample and was calculated as the difference of the other constituents from 100.

$$\%NFE = 100 - (\%CP + EE + CF + \text{ash} + \text{moisture})$$

Methabolizable energy (ME)

This was calculated in kcal/kg according to the formula of Ichaponani (1980) as

$$ME \text{ (kcal/kg)} = 432 + 27.91 (CP + NFE \times 2.25)$$

Where CP = crude protein

NFE = Nitrogen free extract

EE = Ether extract

Amino acid analysis of spent brewers' yeast (*Saccharomyces cerevisiae*)

This was done at the molecular structure facility, University of California, USA using the L-8800 AAA system. Fifty milligram sample was weighed into hydrolysis tube. The sample was soaked in 500 µl formic acid overnight at 4°C and was then dried. Liquid phase hydrolysis was done (400 µl 6NHCl, 1% phenol at 110°C for 24 hours). It was then dried. This was then dissolved in Norleu dilution buffer to the indicated volume. It was then vortexed, spun down and loaded in 50µl using L-8800 ASM (Coung, series: 0792 system) and results printed out.

Results and Discussions

The results of the chemical analysis of spent brewers' yeast is presented in Table 1. Crude protein and crude fibre were 40.52 and 4.31% dry basis respectively. Soya bean has crude protein of 38.00 and crude fibre of 5.01% respectively (Aduku, 2003). These are close enough for the spent brewers' yeast to substitute the soya bean. The metabolizable energy (ME) was 2606.07 kcal/kg which also compares with that of soya bean (insert the value).

Table 1: Proximate/nutritional composition of spent brewers' yeast (*S. cerevisiae*)

Nutritional parameters	Percentage composition (%)	Reference value*
Crude protein (WM)	38.01	
Moisture	6.20	
Crude fat (WM)	0.79	
Crude fat (DM)	0.84	
Crude fibre	4.31	4.80
Gross energy (kcal/kg)	3722.88	
Metabolizable energy (kcal/kg)	2606.07	2800
Ash	14.53	4.70

WM = wet matter; DM = Dry matter

The amino acid profile of the spent brewers' yeast is shown in Figure 1. Both essential and non-essential amino acids were present. However, it was low in cystic acid, methionine and tryptophan. The essential amino acids included leucine (8.42%), valine (6.07%), threonine (5.65%), isoleucine (5.37%), phenylalanine (5.30%), arginine (4.74%), histidine (2.93%), lysine (2.93%) and tyrosine (2.73%). The non-essential amino acids were glutamic acid (14.98%), aspartic acid (11.98%), alanine (7.26%), serine (5.75%), proline (4.84%) and glycine (4.83%). These results compare well with the amino acids found in soya bean (Table 2). The spent yeast even had higher levels of histidine, threonine and valine

than soya bean though slightly higher values are observed for arginine, lysine, methionine and tryptophan for soya bean than in the spent brewers' yeast.

These results showed that spent brewers' yeast has nutritional value and can be used as feed ingredient in poultry feeds to replace soya bean as protein source. However, methionine and tryptophan would have to be supplemented. Considering that the fact that spent brewers' yeast is a waste product of the brewery industry, where such industries are situated, its use will prove cheaper than soya bean all things being equal, especially in Nigeria. Thereby making soya more available for human food.

Table 2: Chemical composition of *S. cereviciae*, and poultry by-products

Composition	<i>S. cereviciae</i>	Poultry by-products
Dry matter (%)	93	93
Metabolizable energy (ME)	1990	2650
Crude protein (%)	44.4	55
Crude fat (%)	1	13
Crude fibre (%)	2.7	1.5
Ca	0.12	3
P	1.4	1.7

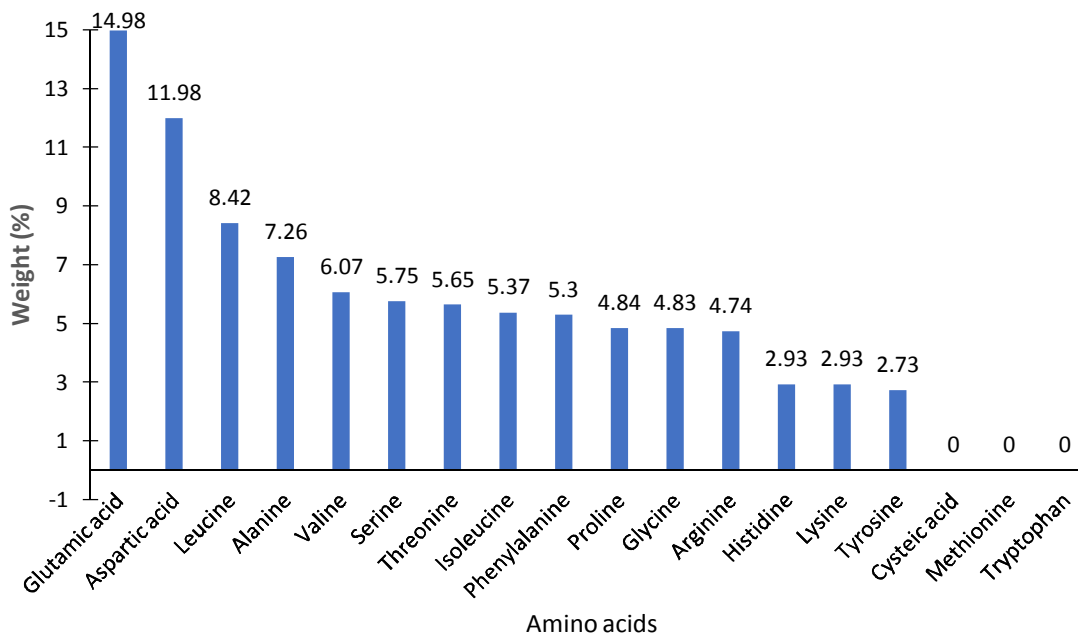


Figure 1: Amino acid profile of spent brewers'

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