

Brewers Spent Grain Obtained From Brewery In Nigeria: Nutritional And Anti Nutritional Status

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Abstract: The level of selected heavy metals, phytochemicals and proximate composition of spent grain obtained from brewery in Nigeria were investigated. The results obtained ranged from 7.04 to 11.43 mg/Kg, Ca; 8.86 to 17.97 mg/Kg, Cu; 120.80 to 130.00 mg/kg, Zn; 221.75 to 229.84 mg/kg, Fe; < 0.001 to 5.10 mg/kg, Mn; Hg and As were not detected. The phytochemical composition ranged from 8.50 to 11.38 %, alkaloid; 3.27 to 5.73 %, flavonoid; 2.40 to 6.90 %, saponin; 0.30 to 0.41%, tannin and 0.29 to 0.32 %, phytate. The proximate composition obtained ranged from 20.00 to 24.00 to 24.00 %, Protein; 8.45 to 10.00 %, starch; 5.50 to 6.80%, Lipid; 4.50 to 4.80 %, ash; 15.90 to 17.03 %, fiber; and 15.99 to 16.40 %, moisture. Results were compared with international/national standard of heavy metals in food, cereals and vegetables and were found to be within permissible limits except the concentration of Cd and Pb that exceeds the tolerance limit.

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1. Introduction

In beer making, brewers spent grain remains the most dominant solid by-product amongst others (brewers spent yeast, spent hops, and diatomaceous earth) (Mussatto, 2009). It corresponding to around 85 % of the total waste produced in brewing (Lima, 2010). Owing to the presence of highly desirable nutritional constituents such as 41.28 % fibers, 18 % protein, 10.1% starch, 16.11 % sugar, 5.7 % moisture (Farcas et al., 2014) and readily obtainable sugars, amino acids, cellulose and lignin (Bisaria et al., 1997), brewers spent grain has been considered a suitable supplement in human diet and feed for animals. Malu et al., (2014) reported high levels of heavy metals Fe, Zn, Cu, Mg, Cd and Pb while Ifut et al., (2015) detected the presence of anti-nutritional factors (saponin, phytate, and tannin) in brewers spent grain.

The present utilization of brewers spent grain as feed supplement for both humans and animals has triggered scientist and researchers to access the level of conformity of the grain by monitoring the distribution of these toxic metals and anti-nutritional factors with the hope of defining the toxicity of the spent grain, so as to attain if the grain are to a certain extent suitable for consumption by human being and animals. This study investigate the concentration levels of heavy metals, essential metals, phytochemicals and proximate composition of spent grains obtained from a brewery in Nigeria.

2. Material and Methods.

Sample Collection

About 2kg of fresh spent grains were collected in a polyethene bags from a Brewery in Port Harcourt, Nigeria from March to June being the preferred planting time and highest yield potential of the source material barley. These samples were labeled; A, B, C and D which represent March, April, May and June respectively. The samples were stored in a cool dry place to avoid bacterial contamination and quickly taken to the laboratory for analysis.

Metals Analysis

5g of dried brewers spent grain in a 250ml capacity beaker, were digested in aqua regia (60ml HNO₃ and 20ml concentrated HCl) and heated in a water bath for about 30 minutes. The digest were filtered using the Whatman filter paper no. 42 into a volumetric flask and were made up to 50ml each with distilled water. The solutions were used for analysis of the following metals Ca, Zn, Cu, Mn, Fe, Cd, Pb, As, and Hg using Flame Atomic Absorption Spectrophotometer (Agilent 55B SPECTRA).

Phytochemical analysis

The concentration of alkaloid, flavonoid, saponin, tannin and total phytate content of the samples were determined using the method according to Harbone, (1973), Bohm and Kocipai-Abyazan (1994), Obadoni and Ochuko (2001).

Proximate analysis

The proximate composition were determined using the following methods; AOAC (1990), James (1995), and Chang (2003).

3. Results

In the pine forest, Asteraceae was represented by nine species followed by Lamiaceae (7 spp.),

Rubiaceae, (3 spp.), Fabaceae, Poaceae, Apiaceae, and

Table 1: Result summary of Essential metal concentration in the various Brewers spent grain samples analyzed.

Metal concentration in mg/kg					
SAMPLE	Ca	Cu	Zn	Fe	Mn
A	11.43 ± 0.08	8.86 ± 0.02	126.90 ± 0.05	227.59 ± 0.09	ND
B	10.80 ± 0.02	11.69 ± 0.01	120.80 ± 0.06	229.84 ± 5.74	ND
C	7.04 ± 0.02	17.97 ± 0.02	127.20 ± 0.05	221.75 ± 0.07	5.10 ± 0.03
D	9.90 ± 0.02	15.37 ± 0.04	130.00 ± 0.02	225.00 ± 0.05	2.65 ± 0.02

Values are mean ± S.D of three determination.

Table 2: Non-Essential Metal Concentration in Brewers spent grain samples.

Metal concentration (mg/kg)				
SAMPLE	Hg	Cd	Pb	As
A	ND	ND	35.83 ± 4.01	ND
B	ND	1.05 ± 0.03	41.33 ± 3.21	ND
C	ND	0.77 ± 0.007	27.56 ± 0.55	ND
D	ND	0.39 ± 0.005	17.84 ± 0.29	ND

Values are mean ± S.D of three determination.

Table 3 Phytochemical Analysis in the Brewers spent grain samples (%)

SAMPLE	ALKALOID	FLAVONOID	SAPONIN	TANNIN	PHYTATE
A	8.50 ± 0.05	4.81 ± 0.02	2.40 ± 0.05	0.41 ± 0.02	0.29 ± 0.01
B	9.35 ± 0.30	5.73 ± 0.23	2.61 ± 0.03	0.30 ± 0.02	0.31 ± 0.03
C	11.38 ± 0.02	3.27 ± 0.02	6.90 ± 0.05	0.40 ± 0.02	0.32 ± 0.02
D	5.04 ± 0.09	3.51 ± 0.03	3.00 ± 0.05	0.39 ± 0.03	0.29 ± 0.03

Values are mean ± S.D of three determination.

Table 4 Proximate Composition of the Brewers spent grain samples (%)

SAMPLE	PROTEIN	CHO	LIPID	ASH	FIBER	MOISTURE
A	24.00 ± 0.01	10.00 ± 0.02	6.80 ± 0.05	4.80 ± 0.04	17.03 ± 0.03	16.40 ± 0.02
B	20.00 ± 0.03	8.45 ± 0.01	5.50 ± 0.03	4.77 ± 0.02	15.90 ± 0.05	15.99 ± 0.01
C	22.98 ± 0.01	9.00 ± 0.02	6.07 ± 0.03	4.80 ± 0.02	16.60 ± 0.03	16.40 ± 0.01
D	23.44 ± 0.02	9.20 ± 0.02	6.80 ± 0.02	4.50 ± 0.01	17.00 ± 0.02	16.39 ± 0.03

Values are mean ± S.D of three determination.

4. Discussions

From the result obtained in table 1, the concentration of essential metals Ca, Cu, Zn, Fe, and Mn ranged from; 7.04 ± 0.02 mg/kg to 11.43 ± 0.08 mg/kg, 8.86 ± 0.02 mg/kg to 17.97 ± 0.02 mg/kg, 120.80 ± 0.06 mg/kg to 130.00 ± 0.02 mg/kg, 221.75 ± 0.07 mg/kg to 229.84 ± 5.74 mg/kg, and <0.001 to 5.10 ± 0.03 mg/kg respectively. The concentration of Cu in this study exceeds the tolerable value of 10 mg/kg by World Health Organization (WHO 1996) and there was a significant difference in the level of copper in all samples. However, the concentration of Zn, Fe and Mn obtained, far exceeds the maximum permissible limit of the international/national standard of heavy metals in food which are 0.1 mg/kg, 0.3 mg/kg and 0.02 ppm respectively. The mean concentrations of the essential metals in the grain

were in the order Fe > Zn > Cu > Ca > Mn which was in consonance with the results obtained by Resch (2006) and Rosenau et al., (2008).

The concentration of heavy metals analyzed were presented in table 2. The concentration of Cd ranged from < 0.001 to 1.05 ± 0.03 mg/kg while in contrast to the international/national standards of heavy metals in cereals and vegetable is 0.1ppm shows that the concentration of Cd is within the recommended standard. The low concentration of Cd so obtained is agreeable being highly toxic and no biological use. Pb concentration ranged from 17.84 ± 0.29 mg/kg to 41.33 ± 3.21 mg/kg. The results were compared with the international/national standard of heavy metal in all food in solid form (6 ppm). It was observed that the concentration of Pb exceeds the recommended standard. This may be attributed to

pollution of the soil. Hg and As were not detected at < 0.001 mg/kg detection limit. There was a significant difference in the levels of Pb and Cd in all samples analyzed.

The result obtained in table 3 showed that all samples analyzed contained appreciable amount of alkaloids, flavonoids and saponin at concentration ranging from $5.04 \pm 0.09\%$ to $11.38 \pm 0.02\%$, $3.27 \pm 0.02\%$ to $5.73 \pm 0.23\%$, and $2.40 \pm 0.05\%$ to $6.90 \pm 0.05\%$ respectively. This depends not only on the choice of barley cultivar (Adams et al., 2001) but also on the mode and efficiency of extraction used (Farcas et al., 2013). There was a significant difference in the levels of alkaloid, flavonoid and saponin in all samples analyzed. Though alkaloid and saponin possess diverse physiological functions, they are also known to play a major role as antioxidants, free radical scavengers, as well as anti-carcinogenic agent. The lower levels of tannin and phytate obtained at concentrations ranging from $0.30 \pm 0.02\%$ to $0.41 \pm 0.02\%$ and $0.29 \pm 0.01\%$ to $0.32 \pm 0.02\%$ respectively, is agreeable as they bind protein thereby limiting their availability and palatability in the diet and hinders the absorption of divalent metals in the body (Osagie et al., 1993). The mean concentration was in the order alkaloid > flavonoid > Saponin > Phytate > Tannin.

The results of the chemical composition of brewers spent grain presented in table 4 above, shows high level of protein and fiber at concentration ranging from $20.00 \pm 0.03\%$ to $24.00 \pm 0.01\%$ and $15.90 \pm 0.05\%$ to $17.03 \pm 0.03\%$ respectively and low level of starch at concentration ranging from $8.45 \pm 0.01\%$ to $10.00 \pm 0.02\%$. This can be attributed as greater portion is transformed into fermentable sugar during mashing process (McCarthy et al., 2012; Kissel and Prentice 1978). The high amount of protein and fiber in the grain, makes it a suitable supplement in the diet as it inhibits the growth of cancer, diabetics, coronary heart diseases and hypertension (Aman et al., 1994). The concentration of ash at $4.50 \pm 0.01\%$ to $4.80 \pm 0.04\%$ in the grain is in consonance with results reported by Dung et al., (2002) and Musatto and Roberto (2005). High ash content of feed dilutes the amount of nutrients available to animals. The results of the lipid and moisture content obtained were lower than those reported by researchers such as; Santos et al., (2003), and Farcas et al., (2012).

Conclusion

The result obtained from this study has revealed that spent grain obtained from brewery is endowed with essential metals Ca, Cu, Fe, Zn, and Mn, secondary metabolites alkaloid, flavonoid, and saponin as well as highly desirable nutritional characteristics with high levels of carbohydrates, protein, lipid, fiber and moisture. Therefore is

considered a suitable supplement for humans and as feed formulation for animals.

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