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Evaluation of the Physico - Chemical Properties of Acha (Digitaria Exilis) for the Beverage Industries in Nigeria

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Abstract: ***The physicochemical properties of Acha were studied with a view of establishing its suitability or otherwise as substitute for barley in some beverage industries. The physical properties showed that acha is amber white colour; its kernel is tiny in size between 0.4-0.8 mm (using varniercalipers) in diameter. AOAC (2000) method was used in determining the starch content which was found to be 60.20 ± 0.007, which compares favourably with 60-80% for commercial grains. The percentage protein was 15.06 which are above that of barley at 10-13%. The reducing sugar was determined by the method adopted by Kent Jones (1999) was 6.37% and water sensitivity using Hugh et al (1981) was found to be 43-45% which is ideal for standard grains. The germination capacity using the afore-mentioned method was 93.6% which proves that the diastatic enzymes are actively present. From the results obtained, there is strong indication that acha has a great potential in the beverage industries especially the brewing industry.***

Keywords: acha, malting, enzymes, brewing, diastatic

1. Introduction

The major cereal grains of the world are wheat, rice, maize, barley, rye, sorghum and millet. Among the other numerous grains that are not as popular as those mentioned, are a group of tiny grains called fonio, (*digitaria exilis*) popularly known as acha in the Northern parts of Nigeria. It is grown in many parts of the tropics most especially West Africa and Central Africa.

Digitaria Exilis popularly known as Acha in the Northern part of Nigeria where is grown, is one of the oldest cereals in Africa (Gibbon and Paine, 1985). It is referred to as the lost crop of Africa (Dung et, al. 1999). Acha is a staple food in some parts of Northern Nigeria (Plateau, Kaduna, Kebbi, Niger), (Bulus 2000) and in some West African countries such as Mali, Ghana and Burkina Faso (Irvine, 1979). It is grown in those parts of the world, because of its adaptability to the climate and soil condition prevalent in those areas.

In keeping with the Federal Government policy geared towards encouraging import substitution, and reliance on locally available raw materials, it has become necessary to examine the suitability of this locally available raw material, (Acha) for industrial purposes, since it is widely grown in the Northern parts of the country.

The malting and brewing industry in Nigeria is one of those that have witnessed a sustained growth with resultant contribution to the economy of the country. For instance, the brewing industry contributed 0.74% between 1976-1977 to the economy since then, the sector has witnessed a tremendous growth to about 11.72% in 2000 (Mensa, 2000; Adobi, 2001).

The phenomenal growth in the brewing sector is estimated at 100% per annum (Okechukwu, et al., 1984) and is expected that this growth will continue in the future. The proliferation of breweries in the country and the need to meet the ever increasing demand for the malt beverages has informed the research into malt substitute and other important brewing ingredients. In recent years, malting of cereal grains other than barley has attracted much attention; this is because of local and economic consideration. This reason has also prompted the investigation in to the malting characteristics of Acha in order to determine how suitable it will be as a replacement for barley in the ever growing Nigerian brewing industry.

2. Materials and Methods

The Acha (Digateria Exilis) Staf was obtained from TafawaBalewa local Government market in Bauchi State.

Proximate analysis
The proximate analysis for cereal was carried out using the method described by the Association of Official Analytical Chemist (AOAC, 1980).

Moisture content
The AOAC (2000) with slight modification was used in the estimation of the moisture content of the grain and the malt. A hot air oven (H562A) at a temperature of about 100-105^{O}C for three (3) hours, was employed.

$$\%\text{moisture} = \frac{\text{loss of weight on drying}}{\text{Initial weight of sample}} \times 100 \quad (1)$$

Determination of protein content (Kjeldhal method)
Protein content was determined using Kjeldahl method. 5g of the sample was transferred into a micro digestion flask and 8g of Na_2SO_4 was added to the mixture. The flask and its contents were heated on a Bunsen burner inside a fume cupboard for 1 hour until the mixture becomes clear. It was then cooled. 400ml of ammonia free water was added to the digest. 50ml of 2% boric acid and 1ml of methyl red indicator was measured into a receiving flask of 500ml capacity. The delivery tube tip was dipped not too deep into the boric acid as the digest was made alkaline with 75ml of 5% NaOH. Distillation then proceeded until 25ml of distillate was collected in beaker. The condenser was

washed with 50ml ammonia free water into the distillate. The distillate collected was then titrated with 0.1N H_2SO_4 and the result obtained was recorded.

$$\%N2 = \frac{0.014 \times M \times V}{\text{Weight of sample}} \times 100 \quad (2)$$

$$\%\text{ crude protein} = \%\text{ nitrogen } (N_2) \times 6.25 \quad (3)$$

Where:
M = actual molarity of acid
V = volume of acid used
F = factor = 6.25 for cereals.

Reducing sugar
The reducing sugar was determined by of Kent Jones et al., (1982). The starch of the samples was first hydrolyzed by using the method of direct acid hydrolysis procedure. The dextrose from the aliquot was determined by Lane and Eynon method as described by AOAC 2000.

25ml of Fehling solution (mixture of equal volume A and B) was pipetted into a 200ml conical flask, 15ml of the aliquot was added, it was then heated until it boiled. The standard dextrose was titrated from a laureate into the boiling mixture. 3 drops of 1% aqueous methylene blue solution was added to the boiling mixture and the titration continued until the indicator was gone and the titer value recorded.

Calculations
Lane and Eynon table was used for the calculation and conversion to Dextrose, on the 25ml equivalent of Fehling solution, the result obtained was converted to percentages.

Starch
The starch content of the malt and the grain was determined by the direct acid hydrolyses method as described by AOAC (1980). 50ml of cold water was added to 5gms of the sample and was stirred for an hour. The content was then filtered and washed with 250ml of cold water. 250ml of H_2O was added to the residue and heated for 2 hours 30 minutes with 20ml of hydrochloric acid in a reflux condenser. The content was cooled and neutralized with sodium hydroxide (NaOH) solution. 250ml of distilled water was added and filtered. The aliquot was then determined using Lane and Eynon method.

The starch content of the sample was calculated as follows:

$$\%\text{ starch} = \%\text{ dextrose obtained} \times 0.90 \quad (4)$$

Malting
About 10gms of Acha (Digitaria exilis) was steeped in water at 32^OC for 72 hours. The weight was noted at different time intervals. Initially, the weight was taken at 2 hour intervals and later at 4 hour intervals. The increase in weight of the sample was recorded. The malting was carried out for a maximum of six days. Formaldehyde (0.02%, V/V) was used to deter mould growth. Samples were moistened on a daily basis to prevent desiccation. The samples (duplicate) were steeped for 72 hours at room temperature (32^OC – 35^OC) on a Whatman No.1 filter paper in a 9 cm petri dish containing 48ml water (Hough, et al., 1981). The number of kernels which germinated in petri dishes containing 4ml was reported as germination energy and the number of those found resistant to germination in the presence of 8ml water was expressed as water sensitivity.

3. Results and Discussion

Bio-Chemical Analysis of Acha Grain and Malt

Table I: Proximate Composition

S/no	Constituent %	Acha Grain
1	Moisture Content	6.66 ± 0.005
2	Protein (N x 6.25)	15.06 ± 0.008
3	Ash	1.74 ± 0.002
4	Starch	60.20 ± 0.007
5	Free Amino acid	2.21 ± 0.016
6	Reducing Sugar	2.80 ± 0.026
7	Dextrose	3.07 ± 0.005

Table II: Proximate Composition of Acha Malt

S/no	Constituent %	Acha Grain
1	Moisture Content	40.40 ± 0.007
2	Protein (N x 6.25)	11.48 ± 0.009
3	Ash	1.90 ± 0.006
4	Starch	49.20 ± 0.017
5	Free Amino acid	3.05 ± 0.006
6	Reducing Sugar	6.37 ± 0.0017
7	Dextrose	4.23 ± 0.014

3.2 Physical and chemical properties of Acha Grain

Table III

1	Germination energy	93.51 ± 0.009
2	Water sensitivity	35.55 ± 0.04
3	Germination capacity	95.6 ± 0.07
4	Percentage foreign matter	0.65 ± 0.018

Table IV: Biochemical properties of Acha Grain

1	Malting loss	9.65 ± 0.007
2	Diastatic power in linter degree	13.57 ± 0.007

4. Discussion

For a good mating characteristic from cereal, the moisture content of 9-12% has been reported by Casble et, al. (1992), he suggested that moisture content below this value may likely affect the enzyme activity during malting. The moisture content of the acha in Table 1.0 fall below the recommended level of good quality grain for malting. The moisture content of 6.66% suggests that it contains high amount of dry matter and the grain might have been in the store for a long time. The protein level of the acha of about 15.06% is slightly above that of barley, the chief material for malt production, which is 10-13%, sorghum 5-12%, Nwasike, et al. (1982), Asien (1989). It is apparent that wort from acha malt yield is certain, since it is dependent on the total soluble nitrogen and free amino acid nitrogen level (pierce et al., 1999).

Starch is an important factor in brewing because it provides the basic substrate for enzymes activities during malting process and wort production; 60-80% starch content has been reported by Novelloe (2001) for most commercial grains. 60.20% starch was recorded from the acha grain, this suggest that acha has the capacity to produce high starch extract yield as shown in Table 2., the relative reducing sugar is very high (6.37%) which is an indication that there had not been much enzymatic activities on the grain material. Table 3.0, germination energy and water sensitivity

helps in determining the amount of water that will be required for steeping of the grain thereby knowing the actual time required to achieve 45% water content. Obio (1991) reported that water sensitivity of 43-45% is ideal for grains of commercial standard. Germination of 93-95% is required of grains for commercial purposes. Acha's germination energy of 93.5% falls within the recommended range for a quality malt.

Diastatic power measures the capacity to convert malt by enzyme diastase. From Table 4.0, the grain has a diastatic power of 13.57% which proves that there are enough diastatic enzymes. The range of commercial diastatic power is between 25-45 degree lintner (OL) Novelloe (2001) and malt with diastatic power of 20^0 or less would bring about incomplete starch conversion and that malt will be of low quality.

The diastability of malt could be increased by the addition of commercial gibberallic acid during malting or better still the addition of exogenous enzymes during mashing. From Table 2.0, the starch content of the malt tends to decrease when compared with the starch of the raw materials. Acha grain has a starch content of about 60.30% and 49.20% malted grain. The decreased in value may be due to enzymatic degradation of starch to oligosaccharide Okafor et, al. (1981), the fermentable sugar content of the same acha grain increased from about 2.50% to about 6.37%, this agrees with work of Hough et al., (1971) who posit thatabout 5-10% of starch is hydrolyzed during malting.The protein content of the malt tends to be decreasing when compared with the grain raw materials. From the result, acha has relatively high protein content of about 15.06% and about 11.48%, this suggests the ability of proteolytic enzymes to convert protein nitrogen to amino nitrogen, which steeping characteristic shows the rate of which the grains absorbs water with time during the period of steeping. From fig 2, it is evident that acha grain from the 16th hour, showed rapid water absorption, afterwards, it becomes relatively low.

5. Conclusion and Recommendations

The analysis carried on the cereal shows that there is a remarkable potential for acha in the beverage industry. Some few areas of concern, is the discovery of low diastatic enzymes, such as alpha amylase, beta amylase and few other enzymes which can be fortified with the addition of exogenous enzymes in order to ensure complete conversion during the malting process. It is recommended that more works and studies should be carried out in the area of the enzyme content and their activities, especially of the alpha and beta amylase. Also research should be intensified in identifying varieties that may likely degrade endosperm to sugar which serve as a substitute for yeast.

It is further recommended that more research should be sponsored by the government and the discovery of other hidden potentials in the earst-while hidden crops of Africa which has the capacity of turning Nigeria's beverage industry around.

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