# PHYSICOCHEMICAL PROPERTIES OF DEGERMED FLOURS OF RICE (*Oryza sativa*), MILLET (*Eleusine coracana*) AND WHEAT *Triticun aestivum*)

***[1]Oladebeye, A.A., [2]Amoo, I.A. and [3]Oladebeye, A.O.**

*1. Department of Food Science and Technology, Auchi Polytechnic, Auchi, Nigeria.*

*2. Chemistry Department, Federal University of Technology, Akure, Nigeria. 3. Department of Polymer Technology, Auchi Polytechnic, Auchi, Nigeria. ****E-mail**: ikeohuninioluwa@yahoo.com*

## ABSTRACT

*The flours of degermed grains of rice (Oryza sativa), millet (Eleusine coracana) and wheat (Triticum aestivum) were analyzed for their proximate compositions, physicochemical properties and mineral compositions using standard chemical methods. The value of moisture content was highest (10.42±0.04%) in millet flour and lowest (10.12±0.03%) in wheat flour. The degermed flour of wheat possessed the highest values in terms of crude protein (14.05±0.06%), fat content (3.03±0.03%) and crude fibre (2.25±0.05%). The ash contents (%) ranged between 1.82±0.02 and 2.12±0.02 while carbohydrate by difference (%) varied from 68.73±0.05 to 87.71±0.02. The pH values of the degermed flour samples ranged from 5.66±0.01 to 6.01±0.01. Amylose and amylopectin contents of the samples were observed as an influence on the values of water absorption capacity, swelling power and solubility. The degermed flour of wheat exhibited outstanding potentials in terms of water absorption capacity (92.30±0.01%), amylose content (18.25±0.01%) and solubility (8.03±0.01%). Of all the flour samples, only wheat flour formed gluten.*

**Keywords:** Degermed flour, swelling power, solubility, amylose, amylopectin

## INTRODUCTION

Cereals are the edible seeds or grains of the grass family, Gramineae [1]. Major cereal crops produced worldwide include wheat, rice, maize, millet, sorghum, oats and rye [2]. The seed portion of cereals consists of numerous components, which basically include three parts: a seed coat or testa (bran), storage organ or nutritive reserve for the seed (endosperm), and a miniature plant or germ. The fruit tissue consists of a layer of epidermis and several thin inner layers a few cells thick. The aleurone layer, which is just below the seed coat, is only a few cells thick, but is rich in oil, minerals, protein and vitamins. Starch and protein are located in the endosperm, which represents the bulk of the grain and is sometimes the only part of the cereal consumed. There is generally a gradient of more protein and less starch per cell from the outer to the inner region of the endosperm [2].

Nutritionally, cereals are important sources of dietary protein, carbohydrates, the B complex of vitamins, vitamin E, iron, trace minerals and fibre [3], and essential amino acids [4]. Betschart [3] has identified that the most general usage of cereals is in cooking, either directly in the form of grain, flour, starch; preparation of alcoholic drinks such as whiskey and beer (barley; sorghum), vodka (wheat), American bourbon (rye), Japanese sake (rice) and so on. Wheat holds a special place amongst the cereals because upon mixing wheat flour with water, an elastic matrix called "gluten" required for the production of leavened breads is formed.

This paper evaluates the proximate compositions, physicochemical properties and mineral compositions of the flours of rice (*Oryza sativa*), millet (*Eleusine coracana*) and wheat (*Triticun aestivum*) with the view to providing possible application as ingredients of weaning foods.

## MATERIALS AND METHODS

### Collection and Sample Preparation

The grains of white and yellow varieties of rice (*Oryza sativa*), millet (*Eleusine coracana)* and wheat (*Triticun aestivum*) were purchased in Akure, Nigeria. The flour samples were produced by cleaning, steeping, degerminating, drying, winnowing and milling the cereal grains. The resulting flours were sieved through a sieve with mesh size 600 $\mu m$ to give fine flours, which were packaged in an air-tight polyethylene bags, labelled and kept in a refrigerator at $4^0$C prior to analysis.

### Methodology

The moisture, ash and crude fibre contents of the flour samples were determined using the standard chemical methods described by AOAC [5]. Soxhlet extraction technique was used to evaluated the fat contents of the flour samples [6] while Kjedahl method was used to determine the crude protein

(N x 5.7 for cereals) contents of the samples as described by AOAC [5]. The contents of carbohydrate of the samples were estimated by difference (% Carbohydrate = 100% - Sum of percentages of moisture, ash, fat, crude fibre and crude protein contents).

The method of Foods and Drugs Administration and Laboratory Services [7] was adopted in the determination of gluten contents of the samples. The method as described by Akintayo [8] for the determination of water absorption capacity was adopted. Amylose contents of the samples were determined as described by the chemical method of Song and Jane [9] while the amylopectin contents of the samples were deduced arithmetically as Amylopectin content = 100% - % Amylose content. The swelling power and solubility of the samples were evaluated using the standard chemical method described by Leach et. al. [10].

**RESULTS AND DISCUSSION**

The results of the proximate compositions of the degermed flour samples are depicted in Table 1. The percentage values of moisture content, crude protein, ash content, fat content, crude fibre and carbohydrate by difference ($p<0.05$) are 10.12±0.03-10.42±0.04, 0.45±0.08-14.05±0.06, 1.82±0.02-2.12±0.02, 0.75±0.02-3.03±0.03, 1.65±0.01-2.25±0.05 and 68.73±0.05-84.71±0.02 respectively. The peak values of crude protein (14.05±0.06%), fat content (3.03±0.03%) and crude fibre (2.25±0.05%) were obtained in degermed wheat flour. Low moisture content obtained for wheat flour (10.12±0.03%) is an indication of high stability of the flour to microbial activity compared to other flour samples. That fat supplies most of the energy required by man [11] suggests the degermed flour of wheat a better source of calories than those of rice and millet.

Table 2 contains the results of the physicochemical properties of the degermed flour samples. The pH values of the sample range between 5.66±0.01 (wheat flour) and 6.01±0.01 (millet flour), implying that the proteins in the samples are not denatures and that enzyme reactions are activated [1]. Out of all the samples, it is only wheat flour that possesses gluten content (11.20±0.00%). This may be due partly to its outstandingly high proportion of crude protein (Table 1) and partly to the presence of glycolipids, which play important role in gluten development during bread making [12]. Gluten breads have been reported to have higher protein and lower starch contents than other breads [13]. The degermed flour of wheat possesses peak values of water absorption capacity (92.30±0.01%), amylose content (18.25±0.01%) and solubility (8.03±0.01%) while the respective lowest values (89.50±0.01%, 16.21±0.01% and 7.95±0.01%) are obtained for the degermed flour of rice. The differences in amylose and amylopectin contents contribute to significant differences in the starch properties and functionality [14]. When starch or flour is added to products as an ingredient, it is the functional properties of the starch of flour that are usually important, not the calories. From the results in Table 2, it appears that the amylose content is proportional to water absorption capacity and solubility of the flour samples. The highest swelling power (8.83±0.02 g/g) is obtained in the degermed rice flour while the lowest (8.56±0.01 g/g) in the degermed wheat flour [10]. Tester et. al. [15] and Zeleznak and Hoseney [16] have reported that the amylose acts both as diluents and inhibitor of swelling, especially in the presence of lipids which can form insoluble complexes with some of the amylose during swelling and gelatinization. The starch molecules are held together by hydrogen bonding in the form of crystalline bundles, called micelles. Thus, swelling power and solubility patterns of starches have been used to provide evidence for associative binding force within the granules [10].

## CONCLUSION

The degermed flour of wheat is a good source of crude protein and calories. If processed into food product, its (wheat flour) low value of moisture content indicates high microbial stability. The peak values of water absorption capacity, amylose content and solubility possessed by the degermed wheat flour may suggest the high commercial quality of this flour in breadmaking.

## REFERENCES


1. Ihekoronye, A.I. and Ngoddy, P.O. (1985). Integrated Food Science and Technology for the Tropics. Macmillan Publ. Ltd., London. pp 11-27
2. Chaven, J.K. and Kadam, S.S. (1989). Nutritional improvement of cereals by fermentation. *CRC Critical Reviews in Food Science and Technology,* 28(5): 349
3. Betschart, A.A. (1982). World food and nutrition problems. *Cereal Food World,* 27:562
4. Phillips, R.D. (1997). Nutritional quality of cereals and legume storage proteins. *Food Technology,* 51(5):62
5. AOAC, Association of Official Analytical Chemists (1990). Official Methods of Analysis of the Association of Official Analytical Chemists. (18th ed.) Washington D.C.
6. Pearson, D. (1976). The Chemical Analysis of Foods (7th Ed.), Longman Group Ltd, London. pp 6-19, 126-127
7. Foods and Drugs Administration and Laboratory Services (1982). Manual of Chemical Methods of Food Analysis. pg 44
8. Akintayo, E.T. (1999). Physicochemical Properties of Protein Concentrates and Starches of African Yambean (*Sphenostylis sternocarpa),* Lima Bean *(Phaseolus)* and Pigean Peas *(Cajanus cajan)*. PhD Thesis submitted to School of Postgraduate Studies, The Federal university of Technology, Akure, Nigeria.
9. Song, Y. and Jane, J. (2000). Characterization of Barley Starches of Waxy, Normal and High Amylose Varieties, *Carbohydr. Polymers 41,* 365-377.
10. Leach, H.W., McCowen, L.D. and Schoch, T.J. (1959). Structure of the starch granules. I. Swelling and solubility patterns of various starches. *Cereal Chemistry*, 36:534-541.
11. Osborne, D.R. and Voogt, P. (1978). The Analysis of Nutrients in Foods. Academic Press, London.

12. Pomeranz, Y. and O. K. Chung (1978). Interactions of Lipids with Protein and Carbohydrates In Breadmaking. *J. Am. Oil Chem. Soc.*, 55: 285

13. Microsoft Encarta Encyclopedia (2005) Microsoft Corporation. All rights reserved.

14. Thomas D.S. and Atwell, W.A. (1999). Starch Structure. In: Starches. Critical guides for the food industry. (Series Ed.), Eagan Press Handbook series. (pp. 1, 2; 25-30). St. Paul, Minnesota, USA.

15. Tester, R.F. and Karkalas, J. (1996). Swelling and Gelatinization of Oat Starches. *Cereal Chem.,* 78:271-273

16. Zeleznak, K.J. and Hoseney, R.C. (1987). The glass transition in starch. *Cereal Chemistry*, 64:121-124.

**Table 1: Proximate Compositions of the Flour Samples**

| Sample | Moisture Content (%) | Crude Protein (%) | Ash Content (%) | Fat Content (%) | Crude Fibre (%) | Carbohydrate By Difference (%) |
|---|---|---|---|---|---|---|
| **Rice** | $10.32\pm0.03^{b}$ | $0.45\pm0.03^{a}$ | $2.12\pm0.02^{c}$ | $0.75\pm0.02^{a}$ | $1.65\pm0.01^{a}$ | $84.71\pm0.02^{c}$ |
| **Millet** | $10.42\pm0.04^{c}$ | $2.48\pm0.04^{b}$ | $1.95\pm0.01^{b}$ | $0.79\pm0.01^{b}$ | $1.70\pm0.01^{b}$ | $82.66\pm0.02^{b}$ |
| **Wheat** | $10.12\pm0.03^{a}$ | $14.05\pm0.06^{c}$ | $1.82\pm0.02^{a}$ | $3.03\pm0.03^{c}$ | $2.25\pm0.05^{c}$ | $68.73\pm0.05^{a}$ |

*Results are the means of triplicate determinations ± standard deviation. Means with different superscripts in the same column are significantly different (p<0.05).*

**Table 2: Some Selected Physico-Chemical Properties of the Flour Samples**

| Samples | pH | Gluten Content (%) | Water Absorption Capacity (%) | Amylose Content (%) | Amylopectin Content (%) | Swelling Power (g/g) | Solubility (%) |
|---|---|---|---|---|---|---|---|
| **Rice** | $5.68\pm0.17^{a}$ | ND | $89.50\pm0.01^{a}$ | $16.21\pm0.01^{a}$ | $83.80\pm0.01^{c}$ | $8.83\pm0.01^{c}$ | $7.95\pm0.01^{a}$ |
| **Millet** | $6.01\pm0.01^{b}$ | ND | $91.41\pm0.01^{b}$ | $17.80\pm0.01^{b}$ | $82.20\pm0.01^{b}$ | $8.65\pm0.01^{b}$ | $7.98\pm0.01^{b}$ |
| **Wheat** | $5.66\pm0.01^{a}$ | $11.20\pm0.00^{a}$ | $92.30\pm0.01^{c}$ | $18.25\pm0.01^{c}$ | $81.75\pm0.01^{a}$ | $8.56\pm0.01^{a}$ | $8.03\pm0.00^{c}$ |

*Results are the means of triplicate determinations ± standard deviation. Means with different superscripts in the same column are significantly different (p<0.05).*