The Impact of Fermentation on the Proximate and Mineral Composition of *Phoenix dactylifera L* Flour

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Abstract: Fermentation was carried out on *Phoenix dactylifera* L. fruit flour. Proximate analysis and mineral analysis were carried out on both fermented and raw sample. The proximate analysis (%) showed that the fermented sample contain higher composition of Moisture, Ash, Crude fat, Crude fibre, and Crude protein except Carbohydrate (64.50 ± 0.01) which is lower compared to the result obtained in the raw sample (76.23 ± 0.02). Mineral analysis (mg/l) of the samples depicted that fermentation increased the Fe (7.64 ± 0.02), Mg (0.96 ± 0.00), Ca (6.26 ± 0.01) and Cu (0.16 ± 0.00) content compared to that of raw Fe (2.17 ± 0.01), Mg (0.94 ± 0.01), Ca (3.13 ±0.07) and Cu (0.13 ± 0.00) in the sample while the composition of Na (1.02 ± 0.90) and K (1.78 ± 0.01) decreased compared with the values of Na (1.28 ± 1.07) and K (2.21 ± 0.02) obtained from the raw fruit flour. The result showed that fermentation transforms the fruit flour into a probiotic food supplement through increased mineral, protein and fibre content thereby enhancing digestibility. The pre-digested carbohydrate content in the fruit flour during fermentation also makes it beneficial for people with diabetes.

Key Words: Fermentation, *Phoenix dactylifera* L, Proximate, Mineral.

Introduction

Fermentation is the process of conversion of sugars to ethyl alcohol under the influence of yeast. Fermentation of sugars by yeast, the oldest synthetic chemical process by man, is still of enormous importance for the preparation of ethanol and certain other alcohols.

Campbell-Platt [1] has defined fermented foods as those foods which have been subjected to the action of micro-organisms or enzymes so that desirable biochemical changes cause significant modification to the food. However, to the microbiologist, the term “fermentation” describes a form of energy-yielding microbial metabolism in which an organic substrate, usually a carbohydrate, is incompletely oxidised, and an organic carbohydrate acts as the electron acceptor [2]. This definition means that processes involving ethanol production by yeasts or organic acids by lactic acid bacteria are considered as fermentations. Whichever definition used, foods submitted to the influence of lactic acid producing microorganisms is considered a fermented food.

It has been reported that generally, a significant increase in the soluble fraction of a food is observed during fermentation. The quantity as well as quality of the food proteins as expressed by biological value, and often the content of water soluble vitamins is generally increased, while the anti-nutritional factors show a decline during fermentation [3]. Adams [2] also reported that fermentation results in a lower proportion of dry matter in the food and the concentrations of vitamins, minerals and protein appear to increase when measured on a dry weight basis. Meanwhile, according to Khetarpaul and Chauhan [4], single as well as mixed culture fermentation of pearl millet flour with yeast and lactobacilli significantly increased the total amount of soluble sugars, reducing and non-reducing sugar content, with a simultaneous decrease in its starch content.

In addition, Obizoba and Atii [5] stated that combination of cooking and fermentation improved the nutrient quality of sorghum seeds and reduced the content of anti-nutritional factors to a safe level in comparison with other methods of processing while mixed culture fermentation of pearl millet flour with *Saccharomyces diastaticus, Saccharomyces cerevisiae, Lactobacillus brevis* and *Lactobacillus fermentum* was found to improve its biological utilisation in rats [6].

Dates (*Phoenix dactylifera L*) are oval-cylindrical, 3–7 cm long, and 2–3 cm diameter. When ripe, range from bright red to bright yellow in colour, depending on variety. Dates contain a single stone about 2–2.5 cm long and 6–8 mm thick. Three main cultivar groups of date exist: soft, semi-dry and dry and the type of fruit depends on the glucose, fructose and sucrose content [7].

Dates provide a wide range of essential nutrients, and are a very good source of dietary potassium. The sugar content of ripe dates is about 80%; the remainder consists of protein, fiber, and trace elements including boron, cobalt, copper, fluorine, magnesium, manganese, selenium, and zinc [8].

Therefore, the present study aimed at using fermentation process to produce *Phoenix dactylifera L* flour and carrying out the proximate and mineral composition to enhance its use in different food formulations and recipes.

Materials and Methods

Sample Preparation

Phoenix dactylifera L. fruits were purchased in Ijebu Igbo, Ogun state, Nigeria. The seeds were removed from the fruits after which the mesocarp was sun-dried extensively and ground using a mortal and pestle until a powdery form is obtained. The powdered sample was divided into two portions, half was soaked in a clay pot containing water and left to ferment for 5 days naturally without the introduction of external fermenting micro organisms.

The soaked substrates was then sieved and the fermented sample was sun dried. Both the raw and the fermented samples were kept in an air-tight container and finally placed in a refrigerator prior the analysis.

Proximate Analysis

Proximate analysis (moisture, fat, crude fibre, protein, ash and carbohydrate) of the raw and fermented samples were carried out in triplicate using the methods described by AOAC [9] while the carbohydrate was determined by difference.

Mineral Analysis

The minerals were analysed from solution obtained by first dry-ashing the raw and fermented samples as described by AOAC [10]. Ash was determined by combustion of the sample in a muffle furnace at 550°C for 6 hours. The residue was dissolved in 0.1N HNO_3 to break the ash and the mineral constituents (Ca, K, Mg, Na, Fe, Cu and Pb) were analyzed separately using an atomic absorption spectrophotometer (Analyst 400).

RESULTS

Table 1: Proximate (%) Analysis of Fermented and Raw *Phoenix dactylifera* fruit flour

	Fermented	Raw
Moisture	10.93 ± 0.02	7.32 ± 0.01
Ash	2.71 ± 0.01	2.19 ± 0.01
Crude Fat	14.86 ± 0.00	9.45 ± 0.02
Crude Fibre	4.69 ± 0.02	1.74 ± 0.00
Crude Protein	7.00 ± 0.02	4.81 ± 0.00
Carbohydrate	64.50 ± 0.01	76.23 ± 0.02

Table 2: Mineral (mg/l) Analysis of Fermented and Raw *Phoenix dactylifera* fruit flour

	Fermented	Raw
Iron	7.64 ± 0.02	2.17 ± 0.01
Magnesium	0.96 ± 0.00	0.94 ± 0.01
Calcium	6.26 ± 0.01	3.13 ±0.07
Sodium	1.02 ± 0.90	1.28 ± 1.07
Potassium	1.78 ± 0.01	2.21 ± 0.02
Copper	0.16 ± 0.00	0.13 ± 0.00

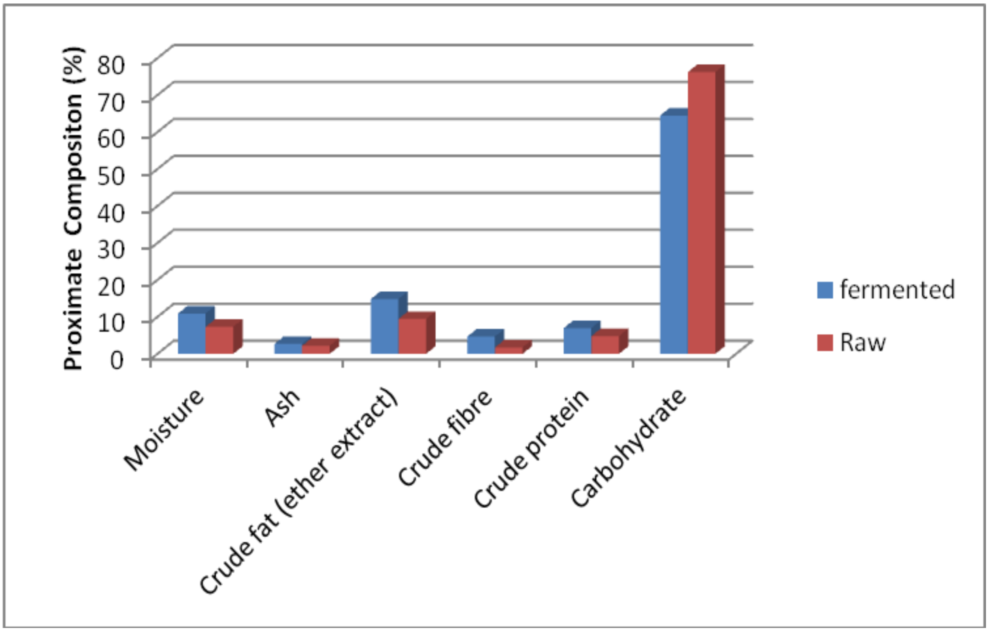

Figure1: Proximate Analysis (%) of Fermented and Raw *Phoenix dactylifera* fruit flour

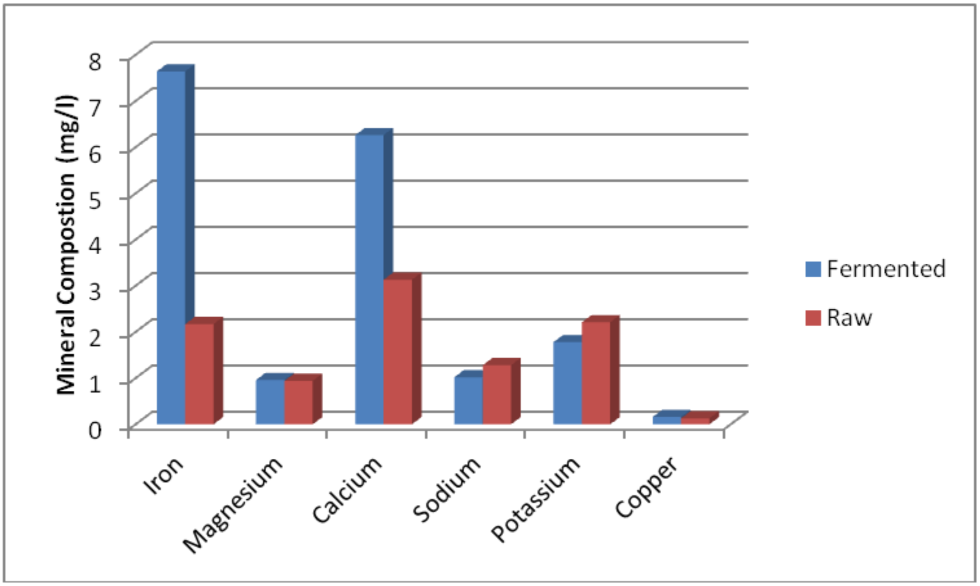

Figure 2: Mineral Analysis (mg/l) of Fermented and Raw *Phoenix dactylifera* fruit flour

Discussion

Result obtained from the proximate analysis of the fermented and raw *Phoenix dactylifera L.* fruit flour as represented in the Table 1 shows that the moisture content of the fermented sample (10.93%) is higher than the value of raw sample (7.32%). This may be due to the absorption of more water through the fermentation process. However, these values are higher than that of Khuzari cultivar (1.6%) reported by Muhammad *et al*. [11].

The decrease in the carbohydrate values because of fermentation may be due to their utilization and transformation by fermentation micro organism to obtain energy and other cellular activities as well as the usual conversion of carbohydrate to ethanol during the process of fermentation. This observation is however similar to that of fermentation by Oladele and Oshodi [12].

However, the crude protein content of the fermented sample is significantly higher compared to the raw samples. Moreover, these values are both higher than that of *Safri cultivar* (2.60%) reported by Kadam *et al.*,[13] but similar to that obtained when pure strain of *Aspergillus niger* was used to ferment maize cobs by Oseni and Ekperigin [14]. This high protein contents could be attributed to the ability of the micro organism to secrete some extra cellular enzymes (proteins) which degrade the materials during fermentation.

The ash content of fermented sample is slightly higher (2.19%-2.71%) than the raw sample, which are both lower than that of Berhi cultivar (2.80%) reported by Kadam *et al.*

[13], this increase may be due to contribution by fermentation micro organisms in the breakdown of the organic components of the fruit samples during the period of fermentation. [12, 14].

The crude fibre content of the fermented sample (4.69%) is higher than that of the raw sample (1.74%) which are both lower than that of Daki cultivar (62.11%) reported by Muhammad *et al.,* [11]. This shows that the fermented fruit can be a good source of dietary fibre which can prevent cardiovascular disease and enhance effective functioning of human digestive tract [15]. In addition, the crude fat (ether extract) of the raw sample is also lower than the value of the fermented sample. These values are both higher than 3.5% reported for millet (*Pennisetum americanum*) [16]. The increase in crude fat could be as a result of extensive breakdown of large molecules of fat into simple fatty acids.

Moreover, the fermentation of *Phoenix dactylifera L.* also caused an increment of most essential mineral contents as presented in Table 2. The content of Fe, Ca, Mg, and Cu present in the fermented sample are higher than that of the raw sample. Meanwhile, values of Na (1.02 ± 0.90) and K (1.78 ± 0.01) of the fermented sample are both lower compared with that of the raw sample whose values are Na (1.28 ± 1.07) and K (2.21 ± 0.02) respectively. This may be due to leaching of soluble minerals into the processing water during the period of the fermentation. In addition, fermenting microorganisms might have used it for metabolic activities as reported by Osman [17].

In conclusion, fermentation increased the protein level; an increase was also discovered in the fat content, crude fibre content and moisture content except for carbohydrate. Fermentation also caused an increase in the availability of some minerals in the sample. Therefore fermented *Phoenix dactylifera L.* fruit can serve as good source of dietary protein, essential minerals for the body and a probiotic food supplement thereby enhancing digestibility.

The decrease in carbohydrate content in the fruit flour during fermentation reduced the sugar content. This makes it beneficial for people with diabetes because fermentation improves pancreatic function, which is of great benefit. Moreso, the carbohydrates in fermented foods have been broken down or pre-digested. As a result, they do not place an extra burden on the pancreas, unlike ordinary carbohydrate.

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