

EFFECT OF HOUSEHOLD PROCESSING ON THE IRON CONTENT OF SOME SELECTED NIGERIAN STAPLE FOODS

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ABSTRACT

This research aimed at determining the effect of processing on the nutritional (iron) values of some selected staple foods. The work identified green leafy vegetables and starchy food staples used to prepare popular soups and meals consumed in the study area. The effect of household processing on the iron content of these staple foods was carried out using Atomic Absorption Spectroscopy analytical method. In this study it was found that household processing techniques of foods results in loss of iron in terms of quantity most especially cooking. However, iron content was found to increase upon soaking and decortication of beans. The findings of this research shows clearly that, an appreciable amount of nutrients is lost during cooking process, hence cooking water should be retained instead of pouring it away. This reduces nutrients lost to a great extent. Dehulling of maize as well as the polishing of rice should be avoided since these result in losses of nutrients. The husk also serves as a beneficial bulk. Finally, mixed diets from animals and plants sources should be encouraged, since it has a synergetic effect on the nutrients quality and quantity of each other and enhanced nutrients absorption.

Key words: Household processing, nutrient, anti-nutritive, micronutrient requirements, bioavailability.

INTRODUCTION

Iron deficiency anaemia (IDA) is a global health issue with disproportionately high prevalence in women in developing countries. It is the most common nutritional disorder in the world affecting 2 billion people worldwide with pregnant women particularly at risk. WHO data indicates that iron deficiency anaemia is a significant problem throughout the world ranging from 1% (average of 14%) in the industrialized countries to an average of 56% (ranging from 35-75%) in developing countries (Reveize L. *et al*, 2011). In addition to being an independent risk factor for decreased quality of life and increased morbidity and mortality, IDA in women has been linked to

unfavorable outcomes of pregnancy. A pregnant woman is considered to be anaemic if her haemoglobin concentration during the first and third trimester of gestation is lower than 11.0g/dL or lower than 10.5g/dL in the second trimester of pregnancy (Balarajan Y. *et al*, 2011). The major risk groups for iron deficiency include women of childbearing age, pregnant women, and lactating postpartum women (Balarajan Y. *et al*, 2011). According to the National Food Consumption and Nutrition Survey in 2003, 43.7% of pregnant women in Nigeria are iron deficient (Kilpatrick S. J *et al*, 2013). The most common causes of anaemia in Nigeria include; nutritional deficiencies of iron and folate, parasitic diseases such as malaria and hookworm, haemoglobinopathies such as

sickle cell disease and recently human immunodeficiency virus infection (Tiwari M. *et al.*, 2013). In developing countries, maternal iron deficiency and anaemia during pregnancy is a product of many compounding factors, such as maternal malaria, intestinal parasitic infection, recurrent infection, haemoglobinopathies and malnutrition associated with reduced dietary intakes of iron containing diets (Afolabi B. B *et al.*, 2016). Treatment of IDA often involves treating the underlying cause with oral or parenteral iron therapy in patients depending on their ability to tolerate or absorb oral preparations (Shander *et al.* 2014). Oral or parenteral iron therapy should aim at replenishing body iron deficits. Serum ferritin levels are used to determine the proportion of women undergoing prenatal care who has iron deficiency anaemia. Iron deficiency in pregnancy has been defined by the National Academy of Sciences Panel on nutrition and pregnancy as ferritin levels lower than 12 ng per ml. Ferritin levels are considered the gold standard for the diagnosis of iron-deficiency anemia in pregnancy (Shander *et al.* 2014).

Iron deficiency result in the development of hypochromic, microcytic anemia accompanied by a normoblastic, hyper plastic bone marrow that contains little or no hemosiderin. Abnormalities of the gastrointestinal tract, including gastric achlorhydria and associated histological lesions consisting of varying degrees of superficial gastritis and atrophy, have long been observed in iron deficiency anemia (Akerele *et al.* 2017). A loss of plasma protein into the gut as also been in infant with iron deficiency anemia. Intake of food low in iron content leads to iron deficiency anemia resulting to low productivity in women. For this condition to be improved the nutritional status of the populace, the available foods have to be subjected to assessment test. This is Followed by identification of factors that

affect the nutritive value of such foods and its absorption in the system and lastly devising methods to improve their value.

Data on food intakes in Nigerian communities indicate that the food consumed is devoid of essential nutrient such as minerals, Vitamins etc. (Mekonnen *et al.* 2021). Most of the food consumed by the people are from plant sources since animal diet are generally more expensive and often beyond the reach of majority of the populace. Ideally, animal diets have indicated to be more in iron content. The overall intake of iron from different diet varies greatly. Iron intake is most likely to be in adequate where there is a heavy dependence on low cost, highly-energy foods that are low in iron which is of low availability. However, people in developing countries depend mostly on plant diet. In order to ensure that customary diet is adequate and balanced as regard essential nutrient, it therefore becomes necessary that due attention be accorded to food handling prior to consumption. It is for this reason that the present study was embarked upon in order to investigate the effect of household processing on the iron content of some Nigerian foods.

The rational for food processing may be traced to the problem of food deterioration upon storage, thus adversely reducing its palatability and acceptability for consumption. Therefore, food processing which in essence can be described as the handling of food in whatever forms, is aimed at making the food more satisfactory both qualitatively and quantitatively for consumption.

Cooking Process

Cooking is important to make the food save by killing contaminating bacteria, and also to in-activate several heart-labile anti-nutritional factors present in many foods. Among the heart stable factors

includes; legumes, tannins appear to leach out into broth during cooking in water and thus, the level in the grains is reduced to 30% of initial value. Cooking also results in loss of vitamins; The most frequent form in which food legumes or pulses are consumed is as the decorticated products. From a nutritional point of view both these practices namely using grains with or without milling and refining, have several advantages and disadvantages.

Miling Process

In the process of milling food grains, the main objective is to remove the coarse fibrous bran or the seed coat. However, in all these processes the nutrient rich part of the grain, namely the aleurone layer, are also displaced resulting in a product poorer in nutrient content.

The extent of nutrient losses particularly of vitamins and minerals during milling of wheat, maize, rice, sorghum and pulse is very large. The large variation in nutrient losses is attributed firstly to the uneven distribution of this nutrient in the structural parts of the kernels and secondly to the degree of milling. Studies on the trace elements composition of wheat flour of different extraction rate has shown that a major proportion of the phosphorus, magnesium, chromium, zinc and Manganese is located in the bran of the wheat kernel. Removal of the bran during milling results in significant nutrient losses (Akerele *et al.* 2017).

Although the nutrient content of food grain is relatively after milling, the bio-availability of certain nutrient appears to improve considerably. For example, the bio-availability of iron as judged by the percentage of it present as an ionizable fraction was found to improve significantly by milling wheat to refined flour and decortication (Adepoju O.T 2012). Similarly,

in Sorghum, the ionizable iron fraction increase from 18.6%-28.7% indicating a 40% rise in the availability of iron. Complex polysaccharide of the fibrous bran, poly phenolic compounds such as tannin and phytate are all known limit the availability of iron, and removal of these complex substances by milling partly explains the improved iron availability of milled and decortication grains (Adepoju O.T, *et al.* 2017).

Socking/ Germination Process

Socking in water overnight followed by germination or sprouting of the grains is yet another common household practice. During germination several enzyme systems become active and bring about profound change in the nutritive value of pulses. Vitamin C which is practically absent in dry legumes seed, increases insignificant amount after germination. On malting, a process that likewise involved germination, loss of phytate is quite pronounced in both ragi and bajra in overnight soaking 25 to 50% of tannin is lost, probably through leaching. In 24 to 48 hours' germination there is an additional loss of 10 to 25%.

The beneficial effect of these changes in food on germination and malting are reflected in the improved availability of nutrients. Thus, the ionizable iron content in chickpea and wheat progressively increase on germination up to 24 hours. On the removal of the seed coat the ionizable iron is 145 both in the raw and germinated grains of chickpea. In ragi and bajra also, germination on malting enhances the iron availability about eight to twelve-fold.

MATERIALS AND METHODS

Collection of samples: samples were collected from Samaru market. These food samples were classified into groups such as,

legumes, cereals, vegetables, and animal diets.

Chemicals and Reagents

All chemicals used were of analytical grades supplied by the British Drug House (BDH) Ltd. They were all obtained from the store of the National Research Institute of Chemical Technology (NARICT) Basawa Zaria.

Preparation of Samples

All foods sample both processed and raw were dried to a constant weight at 60°C for twenty-four hours. The dried food sample were ashed in a furnace for two to three hours at 500°C.

Soaking

The dry beans were soaked in two liters of tap water for six hours at room temperature, then washed, drain, and processed further.

Decortication

This was done following the pre-soaking as described above. the drained beans were pounded in a mortal with a pestle to remove the seed coat. More water was added which resulted in the floatation of the seed coats on top of the water. These were discarded and the process repeated several times until the decortication was completed. The decorticated beans were grinded into past and use in the preparation of *Akara (Kosai)* and *Moi-moi*.

Preparation of Akara (Kosai) and Moi-Moi.

About 300g of the wet decorticated grains were milled in A.B.U community market with a small milling or grinding machine with equal volume of water added to produce a thick slurry. The milling machine was rinsed with tap water and added to half of the homogenate. All ingredients were

added in good proportion; the resultant smooth homogenate was then redistributed into small polytene bags, tied and then placed in a cooking pot. A little water was added to immerse (but not submerged) the polytene bags and covered tightly with the cover. After cooking for 40 to 50 minutes, then allowed to cool after bringing the pot down from the cooker. Part of the cooked paste (*Moi-moi*) was taken for analysis.

In preparation of *Akara (Kosai)*, the thick slurry was fried with vegetable oil in form of small balls with aid of a small size table spoon. These *Akara (Kosai)* were fried for about 15 to 20 minutes then allowed to cool in a sieve while the oil was getting drained at the same time. Some portion of the *Akara* fried was taken for analysis. In both cases (*Akara* and *Moi-moi*), iron content of each was determined.

Cooking

All cooked samples analyzed were each added 20-30g row to cold water (400-500ml) as the case maybe in a cooking pot and cooled for the required time. For each sample its complete ingredients were added before cooking. The cooking sample were digested and then analyzed.

Dehulling

This was done by adding little amount of water to the grains to wet them, and it was poured into the dehulling machine (Rice milling machine). The hull, bran and other fine particle were removed after air drying and winnowing. All this was carried out in samara market. Part of the dehulled grains was ash, digested and analyzed.

Milling/Grinding

This was done using dying maize samples. The dry milling/ grinding was carried out in samaru market, Zaria.

Dry Ashing Disgestion

This was carried out according to the official methods of analysis of the Association of Official Analytical Chemist (AOAC, 2012).

PROCEDURE:

Accurately weight one gram of the grounded food samples in a clean dried porcelain crucible ashed for 2-3hours at 500°C and was allowed to cool. The cooled ashes were wet with drops of distilled water each and 3-4ml of HNO₃ (1+1) was carefully added. Excess HNO₃ was evaporated on a hot plate set at 100-200°C. the crucible were then returned into the furnace ashing process continuous another 1hour at 500°C. The crucible were then removed, allowed to cool, and 10ml HCL (1+1) was added to each crucible to dissolved the ash and these were transferred quantitatively into different 100ml volumetric flask with the crucible rinsed and added to respective flasks and volume made up to the marked. Part of these were taken to NARICT Lab, where iron contents of the food samples were determined by atomic absorption spectrometry, according to the methods of Association of Official Analytical Chemists (AOAC, 2012).

Determination of Iron (Fe), by Atomic Absorption Spectrometry Principle

In this technique the atoms of an element are vaporized and atomized in the flame. The atoms then absorb the light at a characteristic wavelength. The source of the light is a hollow cathode lamp, which is made up of the same element, which has to be determined. The lamp produces radiation of an appropriate wavelength, which while passing through the flame is absorbed by the free atoms of the sample. The absorbed energy is measured by a photo-detector read-out system. The amount of energy absorbed is proportional to the concentration of the element in the sample.

RESULTS AND DISCUSSIONS

The effect of cooking is shown in Table 1 below; Cooking generally has its own advantages in that it increases the palatability and digestibility of some foods as well as the availability of nutrients. On the other hand, the disadvantage this process has been shown to results in the loss of minerals and vitamins (Akerele *et al.* 2017). Lower iron content was obtained for all the cooked food samples except that of raw and cooked beans which shows a little increase. This could be as a result of the ingredients added.

Table 1: Effect of cooking on the iron contents of some selected Nigerian foods.

Common/ scientific name	Time of cooking (mins)	Concentration (mg/L)	Percentage Concentration (mg/g)	Percentage loss	Percentage retention
Beans (white beans)	0.00	1.0640	0.0106	-6.6038	106.6038
Vigna unguiculata	60.00	1.1326	0.0113		
Ugwu leaf	0.00	6.9027	0.0690	82.6087	17.3913
Teleferea occidentalis	20.00	1.1959	0.0120		
Maize flour	0.00	0.7954	0.0080	23.7500	76.2500
Zea maizs	30.00	0.6089	0.0061		
Beef	0.00	1.6096	0.0161	54.6584	45.3416
Bos taurus	40.00	0.7979	0.0073		
Chekens egg	0.00	0.8502	0.0085	11.7647	88.2353
Gallus domesticus	25.00	0.7266	0.0073		

Table 2: below, an increased was observed in the iron content after soaking and further proceed into *Akara* and *Moi-moi*. This increase could be as a result of the decreased in

phytate and tannin content of the beans as a result of hydrolysis of these anti-nutrients during soaking. Hence; neutralizing the inhibitory effect of the anti-nutrients on the iron contents.

Table 2: effect of soaking and further processing in preparation of *Akara* and *Moi-moi* from beans.

Common/ scientific name	Product beans	Concentration (mg/L)	Percentage Concentration (mg/g)	Percentage loss	Percentage retention
Beans(white beans) Vigna unguiculata	<i>Mio-moi</i>	1.2136	0.0121	-14.1509	114.1509
Beans(white beans) Vigna unguiculata	<i>Akara (kosai)</i>	1.7072	0.0171	-61.3208	161.3208

Table 3. Shows the effect of frying on the iron content of beef and egg which both show a decrease in their iron content after frying.

Table 3: Effect of frying on iron contents of beef and chicken's egg

Common/ scientific name	Time of frying (min)	Concentration (mg/L)	Percentage Concentration (mg/g)	Percentage loss	Percentage retention
Beef	0.00	1.6096	0.0161	45.3416	54.6584
Bos tauru	15.00	0.8801	0.0088		
Chickens egg	0.00	0.8502	0.0085	3.5294	96.4706
Gallus domesticus	05.00	0.8170	0.0082		

Table 4 below shows the effect of dehulling on iron content of maize. The extent of nutrient losses particularly of vitamins and minerals is very large. In this work high

decreased iron content was seen after dehulling. This shows that, the seed coats of grains contained iron which is lost during the processing.

Table 4: effect of dehulling on the iron content of maize

Common/ scientific name	Processing	Concentration (mg/L)	Percentage Concentration (mg/g)	Percentage loss	Percentage retention
Maize grains Zea mays	Whole grain	0.7954	0.0080	0.8000	0.0000
Maize grains Zea mays	Dehulled (surfe)	0.4158	0.0042	0.4200	0.3800

Effect of Decortication

The seed coats which consist mostly of cellulose and anti-nutrients is been removed in decortications after soaking in preparation of *Akara (Kosai)* and *Moi-moi*. Although this process causes loss of nutrients in some food samples, the opposite is observed in beans. This could be due to the hydrolysis of phytate as discussed earlier on above.

The practical significance of simple household methods of food processing is obvious to those working in the field of food and nutrition. There is a great need, of course, to make the consumer aware of the nutritional dimensions of such food processing, which has been discussed in this work. Education and extension personnel, who are juxtaposed in the interface between the consumer and the food scientist, have a significant role to play.

CONCLUSION

Household processing of foods generally results in loss of some vital nutrients in terms of both quantity and at times quality, most especially cooking. Foods whose preparation involves the employment of more than one process; usually shows greater losses possibly due to cumulative effect of such processes.

However, this is different in the case of beans where an increased was seen in cooked beans, *Akara (Kosai)*, and *Moi-moi* respectively after all the processes involved.

RECOMMENDATIONS.

1. From the findings above, it is clear that an appreciable amount of nutrients is lost during cooking process, hence cooking water should be retained instead of pouring it away. This reduces nutrients lost to a great extent.
2. Dehulling of maize as well as the polishing of rice should be avoided since these result in losses of nutrients. The husk also serves as a beneficial bulk.
3. Finally, mixed diets from animals and plants sources should be encouraged, since it has a synergetic effect on the nutrients quality and quantity of each other and enhanced nutrients absorption.

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