Effect of Germination on Proximate Composition of Three Grains from Sudan

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Abstract: The objective of the current research was to investigate effects of germination on proximate composition of wheat (Triticum spp.), millet (Pennisetum glaucum L.) and maize (Zea Mays.) grains for comparison. All the grains were cleaned, washed and germinated at temperature 35 ± 2 °C and relative humidity 95 ± 2% for 48 hours. After germination grains were dried till moisture content 12 ± 2%. Main quality parameters such as protein, moisture, fat, fiber, ash and carbohydrates were determined in grains during their germination. Non germinated grains were used as a control sample. In the present experiments significant (P ≤ 0.05) reduction in protein content was observed in the analyzed three grains during their germination for 48 hours which have been attributed to their degradation by proteases. Moisture content of all studied cereals was increased significantly (P ≤ 0.05) during germination. Ash was increased only in wheat after germination while decreased in millet and maize significantly (P ≤ 0.05). Non-significant (P ≥ 0.05) changes were obtained in fiber and carbohydrates content of wheat after germination process and fat content in maize and millet after germination. Study revealed that germination for 48h could be an effective way of improving the fiber content in foods. The discrepancies between these studies could be related to differences in germination time and different sources of grains used in the study. Finally it was recommended to introduce germinated flour in bakery industry because it is of high carbohydrates content. As well as in our daily life because it is easily to be prepared at home so we can save time and money.


1.1 INTRODUCTION

Cereals like Sorghum, Millets, Wheat, Maize and Rice are major staple foods of the most population. These cereals are grown over an area of 98.6 m ha producing 162 m tons in Africa (FAO, 2011). Whole grain cereals have been found to be a good source of nutritionally valuable substances, such as carbohydrates, proteins, minerals, sugars, starch and dietary fiber. The health benefits of cereals are primarily caused by their phytochemicals including phenolic acids, flavonoids, vitamins, fiber, and minerals, which act together to combat oxidative stress, inflammation, hyperglycaemia, and carcinogenesis (Poutanen, 2012; Wang et al., 2013). Cereals are largely consumed as inexpensive sources of energy, they prepared in many form like bread and to a lesser extent as cakes, crackers and breakfast cereals. Millet is the main staple foods in the rural areas of Northern Sudan, and usually is fermented at room temperature at domestic house after milling to produce table food such as Kisra and Asida .While wheat and broad beans are principally consumed in the urban areas (Abuelgasium, 2001). They consumed in other forms like boiled, crushed, or rolled, made into pasta. According to the FAO/Sudan Production and Food Security Assessment conducted in 2010, cereals-mainly sorghum, millet and wheat account for about 53% of the per capita per daily energy requirement of the population. In sub-Saharan Africa, maize is a staple food for an estimated 50% of the population and it remains the most important agricultural crop for over 70 million farm families worldwide.

Wheat is the primary cereal grain and bread wheat represents the most important wheat species worldwide to be used as food ingredient in human nutrition (Rosenfelder et al., 2013). Wheat is mainly appreciated as a source of carbohydrates and proteins (albeit poor in some essential amino acids, especially lysine), but contributes also a significant proportion of fiber, minerals, and antioxidant compounds to the human diet (Ward et al., 2008; Hidalgo et al., 2016).
Several methods have been generally adopted to improve the nutritional and organoleptic qualities of cereal-based foods. These include: genetic modification, amino-acid fortification, supplementation or complementation with protein-rich sources and processing techniques which include malting, milling and fermentation (Laxmi et al., 2015).

Germination and malting of cereals is a way not only to produce fermentable extract for industries, but can also be a way to produce ingredients enriched with health promoting compounds (Hübner and Arendt, 2013).

Germination of grain commences with the uptake of water. Once germination is initiated, the predominant endosperm reserves, starch, cell wall, and storage proteins, are mobilized by the action of hydrolytic enzymes, which are synthesized in the aleurone layer and secreted into the starchy endosperm of germinating grains (Shaik et al., 2014). During germination, endogenous enzymes of cereal grains are activated, and some major substances such as starch and protein undergo degradation to small molecules.

2.1 Sample Collection

Three cereal grains (wheat, *Triticum aestivum*), (millet, *Pennisetum glaucum* L.), and (maize, *Zea mays* L.) were selected randomly from local market of Bahri, in Autumn season. One kilo of each grain was chosen almost of the same size and shape, free of damage, insect and foreign materials. Cereals were purchased and stored in dry and clean plastic polyethylene bags and transported to the laboratory of Food Technology, University of Bahri till further analysis.

2.2 Samples preparation

The three cereal samples were prepared for germination process by cleaning form dirty and foreign particles, only health and fit seeds were chosen. Then they were homogenized, weighed and assigned for two groups, one for running germination process and labeled as GM (germinated millet), GW (germinated wheat) and GMA (germinated maize). The other part was homogenized, milled and used as raw for proximate composition without germination having the following label NGW (non germinate wheat, NGM (non germinated millet) and NGMA (non germinated maize). All samples were kept in deep freezer at -18 °C in polyethylene bags for analysis.

2.3 Germination Method

Germination of wheat, millet and maize was done according to the method of Inyang and Zakari, (2008). About 500g of cleaned seeds were washed three times in tap water, soaked for 12h in tap water (1:3 w/v) at room temperature (32±2°C). After soaking the grains were drained and uniformly spread on wet jute sacks or cotton cloth. The grains were covered with another cotton cloth and water was sprinkled on the top. Germination was carried out at room temperature (32±2°C) for 48h. The grains were devegetated, moldy seeds were removed by hand and the sprouted seeds washed with tap water before drying in hot air oven at 100°C (or sun dried) for 6 h to about 12% moisture content. The dried, germinated grains were dehulled by...
washing in tap water to remove the bran. The dehulled grains together were milled into flour using hammer mill. The flour from germinated grains was kept in plastic bags at freezer (-18 °C) for further analysis.

2.4 Proximate Composition Analysis

Proximate compositions of germinated and non germinated (wheat, millet and maize flour) were carried out according to the methods of AOAC, 2005.

2.5 Statistical Analysis

The analysis of data was carried out by using one-way analysis of variance (ANOVA). Tukey LSD (Least Significant Difference) test and Paired-sample T test were done to determine the significant difference at P≤0.05 level. The Software for statistical analysis SPSS version 20.0 (IBM-SPSS, Chicago, IL, USA) was used.

RESULTS AND DISCUSSION

3.1 Proximate composition of (wheat, millet and maize)

The chemical analysis is important because it provides useful information to the nutritionist who are interested in developing them into high protein foods safety for consumers (Farhat and Chaudhry, 2011). Additionally, chemical composition could influence the storage and could assist in determining the suitability of different species to specific processing and storage techniques Therefore, processors have direct interest in the proximate composition of cereals in order to know the nature of the raw material before germination (Opstvedt, 2000).

3.1.1 Proximate composition of wheat (Triticum ssp)

Table 1. Illustrate the (moisture, protein, fat, ash, fiber, and carbohydrates) of wheat before and after germination. Results indicate that moisture, fat and ash contents were increased significantly (P ≤ 0.05) as a result of germination from (8.26 - 9.78%) - (2.60 - 2.81%) - (1.61 - 1.76%), respectively. This result is within the finding of (Osman, 2011). Germination process decreased the protein of wheat significantly (P ≤ 0.05) from (11.63-10.26%). Effect of germination on protein seems to be conflicting. Protein has been reported to increase upon germination depending on type of grains/seed (Laxmi et al., 2015). However, other scholars (Bhathal & Kaur, 2015) have reported a reduction in total proteins. Protein losses during germination have been attributed to their degradation by proteases. This result of protein reduction is within the finding of Onyango et al., (2013) who found reduction in total protein of wheat after germination.

Table 1: Proximate composition of germinated (G) and non germinated (NG) wheat as % (dry weight basis)

<table>
<thead>
<tr>
<th></th>
<th>Moisture</th>
<th>Protein</th>
<th>Ash</th>
<th>Fiber</th>
<th>Fat</th>
<th>CHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>NG</td>
<td>8.26</td>
<td>11.63</td>
<td>1.61</td>
<td>1.39</td>
<td>2.60</td>
<td>74.56</td>
</tr>
<tr>
<td>G</td>
<td>9.78</td>
<td>10.26</td>
<td>1.76</td>
<td>1.59</td>
<td>2.81</td>
<td>74.18</td>
</tr>
<tr>
<td>T calculated</td>
<td>27.338</td>
<td>6.084</td>
<td>43.00</td>
<td>1.579</td>
<td>7.810</td>
<td>2.526</td>
</tr>
<tr>
<td>P value</td>
<td>0.01</td>
<td>0.026</td>
<td>0.01</td>
<td>0.255</td>
<td>0.016</td>
<td>0.127</td>
</tr>
<tr>
<td>Sig.</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>Ns</td>
<td>**</td>
<td>Ns</td>
</tr>
</tbody>
</table>

N=3
T table 0.05 = 2.776
T table 0.01 = 4.604
T.test. The significance level was set at the probability level (p≤ 0.050).

There was a reduction after the germination process but insignificant (P ≥ 0.05) in carbohydrates (74.56-74.18%). Reduction of wheat carbohydrates after germination is within the results of Osman (2011). The effect of germination on carbohydrates is largely dependent on activation of hydrolytic and amylolytic enzymes which results into decrease in starch and increase in simple sugars in a time-dependent manner.

Germination and malting facilitate the enzymatic breakdown of carbohydrates into simple sugars through activation of endogenous enzymes such as a-amylase thereby improving digestibility (Oghbaei & Prakash, 2016) as a result of degradation of starch to provide energy for the seed development (Zhang et al., 2015).

For fiber, there was insignificant (P≥0.05) increase of wheat fiber content from (1.39 -1.59%).

Megat et al., (2016) reported increase in dietary fiber of different cereals for six hours.

4.1.2 Proximate composition of millet (Pennisetum glaucum L.)

Table 2 exhibits the proximate composition of millet before and after germination as % on dry weight basis. There was significant increase (P ≤ 0.05) in moisture (8.03-8.23%), fiber (1.34-2.17%) and carbohydrate (68.99-71.82%), while the protein and ash were significantly (P ≤ 0.05) decreased (14.38-10.89, 1.84-1.68%), respectively. The increase of moisture was attributed to the increasing number of cells within the seed becoming hydrated (Nonogaki et al., 2010). The increase in carbohydrates and fiber agreed with the results of the study of Megat et al., (2016) who revealed an increase in total dietary fiber from 29% to 73% in different cereals.
From the results of Table 2, germination could be an effective way of improving the fiber content in foods (Jan et al., 2017). Results of millet also showed relation between fiber and carbohydrates content, the higher carbohydrates content the higher crude fiber, the results of increasing of moisture, fiber and carbohydrate were within the results of (Ahmed et al., 2018).

For fat content of millet after germination there was insignificant (P≥0.05) reduction (5.40-5.36) which was in the line of the study of Jan et al., (2017); who proved that lipid content of cereals slightly increases during the steeping stage of malting but later declines during the germination phase (Traore et al., 2004) as lipids are used for respiration process.

Ash of millet was reduced by germination process which is go through with study of Bhathal & Kaur, (2015) who reported, total protein reduction during germination due to their degradation by proteases which lead to protein losses.

Ash after germination was reduced, which is agreed with the result of Abiose and Ikujenlola (2014). The discrepancies between these studies could be related to differences in germination time and different sources of cereals used in the study.

4.1.3 The proximate composition of maize (Zea mays L)

The ranges of moisture (8.18-9.72%), protein (8.73-6.02%) and fiber (1.59-1.93%) of maize showed the same trend of wheat and millet (Table 1 and 2) since there was significant (P≤ 0.05) increased in moisture and fiber while decreased in protein.

Carbohydrate of maize shows the same trend of millet but not wheat. It increased significantly (P≤ 0.05) from (75.41-76.36%) Desai et al., (2010); Laxmi et al., (2015) reported increase in carbohydrate after germination of millet, wheat and chickpea.

Ash of maize decreased (1.71-1.57%) significantly (P≤ 0.05) to show the same trend of millet. Results of maize also showed relationship between increasing carbohydrates and fiber.

Germinated flour of the three cereals showed high fiber content which is might be useful to prevent the constipation and improving digestibility as a result of degradation of starch to provide energy through activation of endogenous enzymes such as α-amylase.

CONCLUSION

The main target of this study is evaluating the impact of germination on the proximate composition of three popular grains from Sudan (wheat, Triticum ssp), (millet, Pennisetum glaucum L) and (maize, Zea mays L) for 84hours.

The study revealed that germination had significant (P ≤ 0.05) differences on moisture and protein. The discrepancies between parameters could be
related to differences in germination time and different sources of cereals used in the study.

The results obtained from this study confirmed that germination as a processing technique can be used to effectively enhance the nutritional values of millet, wheat, and maize. Germinated grains might offer an alternative for allergic or malabsorption patients to gluten.

Finally it is recommended that germinated cereals should use in bakery industry because it is of high carbohydrates content and should be introduced in our daily life because it is easily to be prepared at home so we can save time and money.

REFERENCES


