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Evaluation of the Functional Properties of Millet Grains Available in the Local Market of Brack Alshati City - Libya

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ABSTRACT

The functional properties of millet grains available in the Brack market were studied. Water absorption capacity (WAC), oil absorption capacity (OAC), solubility, and swelling power (SP) were evaluated. The results showed no significant differences between the first type imported from India and the second type imported from Niger. The water absorption capacity of millet imported from India 2.209 (±0.010) was lower than that of millet imported from Niger 2.256 (±0.090), while the oil absorption capacity of millet imported from India 1.532 (±0.096) was higher than that of millet imported from Niger 1.467 (±0.014). The solubility of millet imported from India 0.557 (±0.004) was lower than that of millet imported from Niger 0.597 (±0.001), while there was no significant difference in the swelling power of millet imported from India 9.7 (±0.2) and millet imported from Niger 9.8 (±0.3).

تقييم الخصائص الوظيفية لحبوب الدخن المتوفرة في السوق المحلى لمدينة براك الشاطئ – ليبيا

عمر الحداد محمد الشريف ومختار المهدي سالم دابي

تمت دراسة الخصائص الوظيفية لحبوب الدخن المتوفرة في سوق براك، حيث تم تقييم القدرة على امتصاص الماء، والقدرة على امتصاص الزيت والذوبانية، والانتفاخ، ولقد أظهرت النتائج عدم وجود فروق معنوية بين النوع الأول المستورد من الهند والنوع الثاني المستورد من النيجر. كانت القدرة على امتصاص الماء للدخن المستورد من الهند 209.2 (±0.010) أقل منها للدخن المستورد من النيجر 2.256 (±0.090)، بينما كانت القدرة على امتصاص الزيت للدخن المستورد من الهند 1.532 (±0.096) أعلى منها للدخن المستورد من النيجر 1.467 (±0.014). كانت قابلية ذوبان الدخن المستورد من الهند 0.557 (±0.004) أقل من قابلية ذوبان الدخن المستورد من النيجر 0.597 (±0.001)، في حين لم يكن هناك فرق كبير في قوة الانتفاخ بين الدخن المستورد من الهند 9.7 (±0.2) والدخن المستورد من النيجر 9.8 (±0.3).

INTRODUCTION

Millet, as a broad English term, encompasses a variety of small-grained and tropical grains that are characterized by their small seed size. This sets them apart from barley, wheat, rice, corn, and oats (Fuller, D. 2013).

According to (Lu et al,2009), the earliest evidence of awareness and cultivation of foxtail millet, proso millet, and *broomcorn millet* can be traced back 10,000 years in northern China.

During a period when the cultivation of wheat and rice was not widespread, millets served as a staple food in semi-arid regions of East Asia, including China, India, Japan, Russia, Korea, and across the entire Eurasian continent. The significance of foxtail millet and proso or broomcorn millet (Panicum miliaceum) cannot be overstated, as they are among the oldest and most important domesticated crops globally (Malden, 2005; Crawford, 2006).

Millets are classified as cereals and are herbaceous plants that complete their life cycle within a year (Arvanitoyannis and Van Houwelingen-Koukaliaroglou, 2005). They are often referred to as pseudo-cereals and are notable for their high content of carbohydrates, protein, fat, minerals, antioxidants, amino acids, and dietary fiber (Banerjeeet al., 2020).

Millet grains possess a range of nutrients and essential components that make them a valuable complement to major cereal grains. They are characterized by their richness in essential amino acids, proteins, dietary fiber, resistant starch, and various phytochemicals such as flavonoids, phenolics, saponins, and alkaloids. For instance, kodo millet stands out with its highest recorded content of phenolic compounds (10.3%), while proso millet has the highest protein content (12,610 mg/100 g) among different millet varieties (Goudaret al., 2023).

Millets have the potential to serve as a staple crop, replacing other cereals, primarily due to their adaptability to grow in hot and arid regions, their resilience in such conditions makes them a promising alternative for food production (Sruthi and Rao, 2021).

The functional properties of flour play a crucial role in the production, handling, stability, storage, flavor, taste, and texture of food products. These properties are influenced by factors such as the chemical composition, diversity, type, and particle size of the flour. They represent a complex set of interactions among the molecular conformation, composition, and structure of food components, indicating important physicochemical properties (Awuchi et al., 2019).

Several studies have mentioned the possibility of using millet grains as a functional component in various foods and benefiting from their nutritional value, which requires studying their functional technical properties such as water binding, oil binding, solubility, and swelling capacity. Since there are no local studies evaluating the functional and technical properties of millet grains in southern Libya, this study aimed to assess the functional and technical properties such as water binding, oil binding, solubility, and swelling capacity of millet available in Brack markets.

This study aimed to assess the quality of functional properties of millet available in Brack markets.

MATERIALS AND METHODS

Millet grains bring from a local market in Brack. In order to obtain flour, millet grains were ground in the grain laboratory at the Faculty of Food Sciences, Wadi Al-Shati University, Libya.

METHODS

MEASURING WATER AND OIL BINDING CAPACITY

The water and oil (corn oil) binding capacity of millet flour samples were measured by taking 1 g of the sample in a centrifuge tube and adding 10 ml of distilled water or oil, then mixing for one minute and leaving at room temperature for 30 minutes. After that, centrifugation was carried out at 3000 rpm for 10 minutes and the excess water was removed (Abd Elmoneim *et al*, 2017). The water and oil binding capacity results were calculated from the following equation:

Water/Oil Binding Capacity = Weight of bound water or oil (g) / Weight of sample (g)

MEASURING SWELLING CAPACITY

The swelling capacity in water (i.e. measuring the change in sample weight through its ability to absorb water) was determined by taking 1 g of the sample in a centrifuge tube and adding 10 ml of distilled water, then mixing for 1 minute. The samples were placed in a water bath at 80°C for 15 minutes and then cooled to room temperature. After that, the samples were centrifuged at 3000 rpm for 15 minutes (Liu *et al*, 2018). The swelling capacity results were calculated using the following equation:

Swelling Capacity = Weight of swollen sample - Original weight of sample / Original weight of sample

MEASURING SOLUBILITY

2.5g of the sample was weighed in a centrifuge tube and 30 ml of distilled water was added. The sample was mixed for one minute and the mixture was heated in a water bath at 90°C for 15 minutes. The mixture was left to cool to room temperature then centrifuged for 10 minutes at 4000 rpm. The filtrate was poured into a pre-weighed dish and placed in an oven at 40°C until completely dried after 12 hours. The percentage of soluble solids in the dish to the weight of the sample used was calculated (Elkhalifa et al., 2010).

STATISTICAL ANALYSIS

Data are reported as mean ± SD (standard deviation) of three replicates. To determine statistically significant differences between mean values, one-way analysis of variance (ANOVA) was carried out using SPSS software.

RESULTS AND DISCUSSION

WATER BINDING CAPACITY

The results obtained from Table (1) indicated that there was no significant difference between the first type imported from India and the second type imported from Niger. The results were close to a previous study by (Abedin *et al*., 2022) where the water binding capacity of millet flour was 1.523 g/g. In another study by (Wani *et al*., 2022) the water absorption capacity (WAC) of different millet flour samples ranged from 0.93 to 1.43 (g/g). The results of a study by (Azeez *et al*., 2021) to measure water absorption capacity was 3.58 ± 0.03 (g/g) and in a previous study by (Ramashia *et al*., 2018) the water absorption capacity (WAC) ranged from 0.93 ± 0.06 to 1.23 ± 0.06 (ml/g).

The water binding capacity of a flour or isolate is a good factor for knowing the extent to which the flour can be incorporated into aqueous food formulations, especially foods where dough processing takes place. Lower WAC is good for manufacturing soft extrudates and helps know the amount of water available for gelatinization (Giami, 1993).

Higher WAC values indicate that the starch polymers have a loose structure and lower values suggest a compressed structure (Adebowale *et al*., 2012).

Table (1): Water-binding capacity of millet available in the markets of Brack city

Sample	Water Binding Capacity (g/g)
India	2.209^{a}±0.010
Niger	2.256^{a}±0.090

Values are expressed as mean ± standard deviation of three replicates. Values in the same row with the same letter superscript are not significantly different at P ≥ 0.05

OIL BINDING CAPACITY

The results in Table (2) showed no significant difference between the first type imported from India and the second type imported from Niger. In a previous study by (Abedin *et al*., 2022) the result was close to the results obtained, where the oil absorption capacity of millet flour was 0.793 (g/g). In a study by (Wani *et al*., 2022) the results ranged between 1.10 to 1.86 (g/g) for different millet flour samples. In another study by (Azeez *et al*., 2021) the oil absorption capacity was 1.33 ± 0.01 (g/g) and according to another study by (Sonkar *et al*., 2023) the oil absorption capacity was 1.01 ± 0.05 (g/g). It is noted that the results were very close in all the mentioned studies. Oil absorption capacity is considered one of the important functional properties as it helps improve mouthfeel while maintaining food flavor (Awuchi *et al*, 2019).

Surface polarity, amino acid configuration, and protein conformation are factors that affect the water and oil absorption capacity of flour (Chandra, 2013).

Table (2): Oil binding capacity of millet available in the markets of Brack city

Sample	Oil Binding Capacity (g/g)
India	1.532^{a}±0.096
Niger	1.467^{a}±0.014

Values are expressed as mean ± standard deviation of three replicates. Values in the same row with the same letter superscript are not significantly different at P ≥ 0.05

SOLUBILITY

Table (3) shows no significant difference between the solubility of the first type imported from India and the second type imported from Niger. The solubility in the first type was 0.557 ± 0.074 and in the second type it was 0.597 ± 0.061. These results are lower than the result obtained in a previous study by (Abedin *et al*., 2022) where the water-soluble components in millet flour WSI was 3.05 ± 0.18 g/100 g. Solubility is an indication of high biological value, as solubility is an indicator of the readiness of the nutrient material for absorption in the body. High solubility indicates a high percentage of low molecular weight components, and this may be due to the large components such as fiber, protein and starch having undergone enzymatic degradation (Hussain &Uddin., 2012).

Table (3): Solubility of millet available in the markets of Brack city

Sample	Solubility (%)
India	0.557^{a} ±0.074
Niger	0.597^{a}±0.061

Values are expressed as mean ± standard deviation of three replicates. Values in the same row with the same letter superscript are not significantly different at P ≥ 0.05

SWELLING POWER

The results in Table (4) show no significant difference between the first type imported from India and the second type imported from Niger in terms of swelling power. The swelling power of the first type imported from India was 9.7 and the second type imported from Niger was 9.8. These results are consistent with what was obtained by (Azeez *et al*., 2021) in his study where the swelling power was 8.69 ± 0.14 g/g, and what was obtained by (Abedin *et al*, 2022) where the SC was 7.98 ± 0.30 g/g, as (Ushakumari et al, 2004) also found that the SC was 7.1 ± 0.01. This contradicts the result obtained by ((Sonkar *et al*., 2023) in his study where the swelling power was 3.03 ± 0.053. Starch affects swelling strength as it is a major component of grain flour and its structure affects the functional properties of the flour (Wang *et al*., 2012)

Swelling power (SP) is a test that measures the extent of water absorption by flour or starch during the starch gelatinization process. (Nemantu, and Brasoveanu, 2010).

Swelling power gives an indication of the strength of bonding between starch granules (Moorthy and Ramanujan, 1986).

Changes in starch granules are affected by two factors in the aqueous medium – temperature and water availability from the system. (Nemantu, and Brasoveanu, 2010).

Table (4): Swelling capacity of millet available in the markets of Brack city

Sample	Swelling power (g/g)
India	$9.7^{a}\pm 0.21$
Niger	$9.8^{a}\pm0.81$

Values are expressed as mean ± standard deviation of three replicates. Values in the same row with the same letter superscript are not significantly different at P ≥ 0.05

CONCLUSION

The results obtained from this study showed that the types of millet available in the local Brack market that were studied have almost the same functional properties that could help use them as a functional component in a number of food products.

REFERENCES

Abd Elmoneim, O. E., Bernhardt, R., Cardone, G., Marti, A., Iametti, S., & Marengo M. 2017. Physicochemical properties of sorghum flour are selectively modified by combined germination-fermentation. Journal of food science and technology, 54(10), 3307-3313.

Abedin, M. J., Abdullah, A. T. M., Satter, M. A., & Farzana, T. (2022). Physical, functional, nutritional and antioxidant properties of foxtail millet in Bangladesh. Heliyon, 8(10).

Adebowale, A. A., Adegoke, M. T., Sanni, S. A., Adegunwa, M. O., & Fetuga, G. O. (2012). Functional properties and biscuit making potentials of sorghum-wheat flour composite. American Journal of food technology, 7(6), 372-379.

Arvanitoyannis, I. S., & Van Houwelingen-Koukaliaroglou, M. (2005). Functional foods: a survey of health claims, pros and cons, and current legislation. Critical reviews in food science and nutrition, 45(5), 385-404.

Awuchi, C. G., Igwe, V. S., & Echeta, C. K. (2019). The functional properties of foods and flours. International Journal of Advanced Academic Research, 5(11), 139-160.

Azeez, S. O., Chinma, C. E., Bassey, S. O., Eze, U. R., Makinde, A. F., Sakariyah, A. A., ... & Adebo, O. A. (2022). Impact of germination alone or in combination with solid-state fermentation on the physicochemical, antioxidant, in vitro digestibility, functional and thermal properties of brown finger millet flours. LWT, 154, 112734.

Banerjee, P., Maitra, S., & Banerjee, P. (2020). The role of small millets as functional food to combat malnutrition in developing countries. Indian Journal of Natural Sciences, 10(60), 20412-20417.

Chandra, S., & Samsher, S. (2013). Assessment of functional properties of different flours. African journal of agricultural research, 8(38), 4849-4852.

Crawford, G. W. (2006). East Asian plant domestication. archaeology of asia, 77-95.

Elkhalifa, A. E. O., & Bernhardt, R. (2010). Influence of grain germination on functional properties of sorghum flour. Food chemistry, 121(2), 387-392.

Fuller, D. (2013). Millets: origins and development. Springer.

Giami, S. Y. (1993). Effect of processing on the proximate composition and functional properties of cowpea (Vigna unguiculata) flour. Food chemistry, 47(2), 153-158.

Goudar, G., Manne, M., Sathisha, G. J., Sharma, P., Mokalla, T. R., Kumar, S. B., & Ziouzenkova, O. (2023). Phenolic, nutritional and molecular interaction study among different millet varieties. Food Chemistry Advances, 2, 100150.

Hussain, I., & Uddin, M. B. 2012. Optimization effect of germination on functional properties of wheat flour by response surface methodology. International Research Journal of Plant Science, 3(3), 031-037.

Liu, Y., Xu, M., Wu, H., Jing, L., Gong, B., Gou, M, & Li, W. 2018. The compositional, physicochemical and functional properties of germinated mung bean flour and its addition on quality of wheat flour noodle. Journal of food science and technology, 55(12), 5142-5152.

Lu, H., Zhang, J., Liu, K. B., Wu, N., Li, Y., Zhou, K., ... & Li, Q. (2009). Earliest domestication of common millet (Panicum miliaceum) in East Asia extended to 10,000 years ago. Proceedings of the National Academy of Sciences, 106(18), 7367-7372.

Moorthy, S. N., & Ramanujam, T. (1986). Variation in properties of starch in cassava varieties in relation to age of the crop. Starch-Stärke, 38(2), 58-61.

Nemantu, M.R. and Brasoveanu, M. (2010). Functional properties of some non-conventional treated starches In Biopolymers, Sciyo, Elnashar, M. (ed.), ch 17, pp – 319-344.

Ramashia, S. E., Gwata, E. T., Meddows-Taylor, S., Anyasi, T. A., & Jideani, A. I. O. (2018). Some physical and functional properties of finger millet (Eleusine coracana) obtained in sub-Saharan Africa. Food Research International, 104, 110-118.

Sonkar, S., Jaddu, S., Pradhan, R. C., Dwivedi, M., Seth, D., Goksen, G., ... & Lorenzo, J. M. (2023). Effect of atmospheric cold plasma (pin type) on hydration and structure properties of kodo-millet starch. LWT, 182, 114889.

Sruthi, N. U., & Rao, P. S. (2021). Effect of processing on storage stability of millet flour: A review. Trends in Food Science & Technology, 112, 58-74.

Ushakumari, S. R., Latha, S., & Malleshi, N. G. (2004). The functional properties of popped, flaked, extruded and roller-dried foxtail millet (Setaria italica). International journal of food science & technology, 39(9), 907-915.

Wani, H. M., Sharma, P., Gul, K., Bishnoi, J. P., Wani, I. A., Kothari, S. L., & Wani, A. A. (2022). Influence of Υ-irradiation and genotype on the structural and techno-functional properties and microbial quality of Millet flour. Applied Food Research, 2(2), 100181.

Wang, B., Wang, L. J., Li, D., Wei, Q., & Adhikari, B. (2012). The rheological behavior of native and high-pressure homogenized waxy maize starch pastes. Carbohydrate Polymers, 88(2), 481-489.