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Alhydwan (*Boerhavia elegana Choisy*) seed flour: A new approach in bread staling

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Abstract:

In this study, the impact of the addition of alhydwan seed flour on bread staling was investigated by loss of moisture, Alkaline Water Retention Capacity (AWRC), and Scanning electron microscopy (SEM).

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Results showed that the retardation effect of alhydwan seed flour on bread staling was found to be significant. The moisture content and alkaline water retention capacity were determined at different storage time at zero time, 8,24,48,72 h. The moisture content was decreased with the storage period increased, but the rate of loss in moisture content in the presence of ahydwan flour was 12.23% for 15% compared with 35.45% in bread control after 72 h from the baking process complete. It is clear that the values of AWRC was gradually decreased with the storage period increase, the alhydwan make bread more fresh then the control (wheat bread). The freshness reductions were 4.33%, 15.21%, 20.00% and 22.54 for 15% at 8, 24, 48 and 72 h. From the above results, it could be noticed that addition of alhydwan flour caused increase in the moisture content and this increase was accompanied by a decrease the stale rate of bread.

Key words: Alhydwan (*Boerhavia elegana Choisy*), bread staling, A new approach

1. Introduction

Bread is still a widely consumed product, and moreover the wheat bread. In opposition to other food products, bread quality is not spoiled by the microorganism or the endogenous enzyme activity present in the food products. Bread quality is rapidly lost due to staling that begins just when loaves are taken out from the oven. The staling of bread is a very complex process that has been extensively studied (Chinachoti & Vodovotz, 2001; D'Appolonia & Morand, 1981; Kulp & Ponte, 1981; Maga, 1975; Zobel & Kulp, 1996), although the mechanism still remains unknown. The staling involves several physical and chemical phenomena, being the recrystallization of the amylose and amylopectin (Hug-Iten, Escher, & Conde- Petit, 2003; Krog, Olesen, Toenaes, & Joensson, 1988; Schoch & French, 1947; Zobel & Kulp, 1996), both the loss and redistribution of water (Biliaderis, 1992; Czuchajowska & Pomeranz, 1989; He &

Hoseney, 1990; Zeleznak & Hoseney, 1986), and the protein-starch interactions (Every, Gerrard, Gilpin, Ross, & Newberry, 1998; Martin, Zeleznak, & Hoseney, 1991), the most important ones. There have been a lot of studies focused on the search of methods for retarding the staleness. Among the most successful ones are the use of additives and technological aids as emulsifiers and enzymes, respectively (Armero & Collar, 1996; Davidou, Le Meste, Debever, & Bekaert, 1996; Guarda, Rosell, Benedito, & Galotto, 2004; Martı´nez-Anaya, Devesa, Andreu, Escriva´, & Collar, 1999; Rosell, Haros, Escriva´, & Benedito de Barber, 2001; Twillman & White, 1988). The polysaccharide gums represent one of the most abundant raw materials. The researchers have mainly studied the polysaccharide gums due to their sustainable, biodegradable and bio safe characteristics (Rana et al., 2011). The term "gum" is used to describe a group of naturally occurring polysaccharides that come across widespread industrial applications due to their ability either to form the gel or make the viscous solution or stabilize the emulsion systems (Williams & Phillips, 2000) .*Boerhavia elegana Choisy* seeds (common name: alhydwan) is an edible herbaceous member of the Nynctaginaceae family commonly found in Southern Yemen (Boulous, 1988). It has a long history of usage by indigenous and tribal people in the making of cuisines and as one of the staple ingredients in the manufacture of porridge, desserts and savory products. Alhydwan is also consumed as a food supplement in bread and cakes where it is characterized by good flavour (AL-Farga et al., 2014). Characterized seeds alhydwan a high proportion of gum according to the method used in its areas of deployment in Hadramout as a porte-to a Porridge, this property is reflected in the high ability to absorb water, thus increase the number Pieces of biscuits However, up to this date, as far as our knowledge is concerned, there is no literature concerning any study conducted about the seeds. This study, therefore, was intended to fill this knowledge gap. In this study, we aimed at investigating the influence of the addition alhydwan seed flour on bread staling as a new approach.

Materials and methods

2.1. Materials

Wheat flour (13.6% moisture content, 12.5% protein) was obtained from Pengtai Flour Co., Ltd. (Hebei, China). Yanshan yeast, an industrial product in China (Hebei Mali Co., Ltd.), was used as a starter. Dried alhydwan seeds were brought from a local farm in Wad Hadramout City, Yemen in June of 2014 after harvesting, and transported to the Functional Ingredients and Healthy Foods Laboratory of Jiangnan University, Wuxi city, China.

2.2. Breadmaking process

A basic bread formula consisted in wheat flour (2.0 kg), dry yeast (0.8%, flour basis), salt (1.0%, flour basis), and water (60%, flour basis, according to the amount needed for Brabender farinograph to achieve 500 Brabender Units) was used. Prior to mixing, alhydwan flour was incorporated into the ingredients at a level of 5%, 10% and 15% (w/w) and the resultant blend was optimally mixed until dough development. Then the dough was divided into 200 g pieces, hand-rounded, mechanically molded, proofed at 30 ◦C and relative humidity (RH) of 85% for 90min and baked into an electric oven at 195 ◦C for16 min. Loaves were removed from the pans, cooled at room temperature for 1 h, packed in plastic bags and finally stored at 4 ◦C for aging studies.

2.3. Staling rate

Staling rate of bread was determined during 48 h of storage at room temperature using the following methods:

2.3.1. Loss of moisture

Moisture content for bread in tow steps in the fresh and air dried portions was determined according to AACC method 44-18, (1995). daily for two days.

The Moisture content methods as follows:

1. Fill tared Moisture dishes (with covers) with damp grain feedstuffs whose moisture content is to be determined and weigh container (covered) and contents. Record exact weight of damp material.
2. Place metal dishes (cover removed) with contents in warm, well ventilated place (preferably on top heated oven) protected from dust, so that grain will dry reasonably fast and reach approx. air-dry condition in 14-16 hr. In all cases, moisture content of sample must be reduced to 13% or less in this first stage.
3. Weigh dish and contents and calculate % moisture lost in air-drying.
4. Grind air-dried sample to determine moisture in air-dry sample.

Calculation:

Calculate % total moisture in original sample as follows:

$$\text{T.M.} = A + \frac{(100 - A)\,B}{(100)}$$

Where T.M. = % total moisture

A = % moisture lost in air-drying

B = % moisture in air-dry sample as determined

2.3.2. Alkaline Water Retention Capacity

Loaves freshness of each formula was tested by Alkaline Water Retention Capacity (AWRC) according to method of Yamazaki (1953), as modified by Kitterman and Rubenthaler (1971) as follows:

To five grams of bread flour (placed into dry plastic centrifuge tube of 50 ml capacity) 25 ml $NaHCO_3$ solution (8.4

gm sodium bicarbonate dissolved in 1 Liter of distilled water) were added. The tube was stoppered and shaken until all flour was wet, then the mixture was left 20 min. with shaking every 5 min. The contents were then centrifuged at 2500 rpm for 15 min. The supernatant was decanted and the precipitate was left for 10 min. at 45 angle (to get rid of free water). The gain in weight is expressed in percent.

Loss of freshness (%) was calculated using the following equation:

$$\text{Loss of freshness} = \frac{\text{AWRC (zerotime)} - \text{AWRC (ntime)}}{\text{AWRC (zerotime)}} \times 100$$

Where n= time of storage

2.4. Scanning electron microscopy (SEM)

Scanning electron microscopic studies were carried out using a scanning electron microscope (model S3400N VP, Hitachi, Japan). The samples were coated before loading to the scanning electron microscopy. The coated samples were loaded into the system and the image was viewed under 1.0 KV potential using secondary electron image. The image was captured using 11.20 mm Ricoh Camera of 600 x Mag (Wang *et al.*,2008)

3. Results and discussion

3.1. Influence of the addition alhydwan flour on the Staling rate

3.1.1. Effect of alhydwan flour on the moisture content

Water plays a critical role in bread staling. Softening of the crust and hardening of the crumb are related to moist redistribution during storage (Baik and Chinachoti, 2000).

The results are presented in table 1. After baking (at zero time) the moisture content of fresh bread was ranged from 39.18% for control to 43.35% for 15% alhydwan flour bread. The moisture content was determined after 2, 8, 24, 48 and 72 h. It was found that the loss in moisture content was increased by the storage period increase. After 24 h of baking the loss in moisture content of wheat flour bread (control) was 15.11% compared to 9.07% for 15% alhydwan flour bread. The loss percentage was continuously increased after 48 h ranged from 28.99% for wheat bread to 10.80 for 15% alhydwan flour bread. This is partly due to the higher amount of water required for bread preparation in the case of alhydwan flour. Increasing water absorption leads to enhanced starch gelatinization during baking process. (Regers, 1988) indicated that the rate of firming of bread was increased with decreasing bread moisture which affects bread quality. The moisture content was decreased with the storage period increased, but the rate of loss in moisture content in the presence of ahydwan flour was 12.23% for 15% compared with 35.45% in bread control after 72 h from the baking process complete. (Czuchajowska and Pomeranz, 1989) observed that during storage of bread the water content of the crust increased by storage as a result of water transport from the crumb. From the above results, it could be noticed that addition of alhydwan flour caused increase in the moisture content and this increase was accompanied by a decrease the stale rate of bread.

3.1.2. Freshness of bread

Alkaline water retention capacity (AWRC) is a simple and quick test to follow staling of bread. Higher values of AWRC mean higher freshness of the bread. Data in table 8 showed the effect of addition alhydwan flour on the freshness of bread which was stored at room temperature for 72 h. as anticipated, alhydwan flour bread was fresher than wheat bread under the same conditions; consequently, the staling rate was increased for the later. This means that wheat bread staled faster than the alhydwan flour bread. This may be due to the less moisture content in the former than in the later. These data were in agreement with (Mathewson, 2000) who found that in the presence of excess water, starch gelatinized at approximately at which gelatinization occurs increase. gelatinization process starts where starch granules absorbs water, swells and eventually breaks down, releasing the amylose content of the granules. Data of AWRC are presented in table 2. Alkaline water retention capacity was determined at different storage time at zero time, 8,24,48,72 h. Breads were stored in sealed polyethylene bags at room temperature. It is clear that the values of AWRC was gradually decreased with the storage period increase, the alhydwan make bread more fresh then the control (wheat bread). The freshness reduction was 4.33%, 15.21%, 20.00% and 22.54 for 15% at 8, 24, 48 and 72 h.

(Erazo-Castrejon et al., 2001) postulated the relationship between bread firmness and staling. They found that bread firmness increased during the staling experiment for 5 days. They also added that, starch recrystallization has been identified as one of the causes of bread staling.

3.2. Scanning electron microscopy (SEM)

In order to understand the morphology of *B. elegana Choisy*, SEM analysis was performed and the results are presented in figure (1). Scan Electron Microscopy (SEM) has proven to be a useful tool for studying the morphological changes that take place in the starch granules. Scan Electron Microscopy was used to follow the morphological changes in starch granules alhydwan seed flour and the results are presented in figure (1). It can be observed from the figure that *B. elegana Choisy* consisted starch granule within intercellular space covered with cell wall (fiber). This suggested the presence of polysaccharides. Unfortunately, Up to date there is no information available in the literature regarding this seeds to corroborate these facts.

4. Conclusion

This work demonstrated that alhydwan seed flour has significant impact on the bread staling. The use of alhydwan seed flour in breadmaking allows improving the bread quality, moisture content and texture, and even the sensory quality of the fresh bread was superior to that of the control. The microstructure analysis suggests the existence of multiple gum which could explain the addition of alhydwan into bread may leads to increased water absorption and therefore lead to retard the bread staling process.

Table 1. Effect of addition alhydwan flour on the moisture of wheat flour bread during storage period.

	Storage time (hrs)								
	at zero time	8	% loss	24	% loss	48	% loss	72	% loss
Control	39.18	36.77	6.15	33.26	15.11	27.82	28.99	25.29	35.45
H/F %5	40.62	39.84	1.92	36.62	9.85	35.83	11.79	35.13	13.52
H/F %10	42.09	41.32	1.83	38.22	9.19	37.39	11.17	36.56	13.14
H/F %15	43.35	42.25	2.54	39.42	9.07	38.67	10.80	38.05	12.23

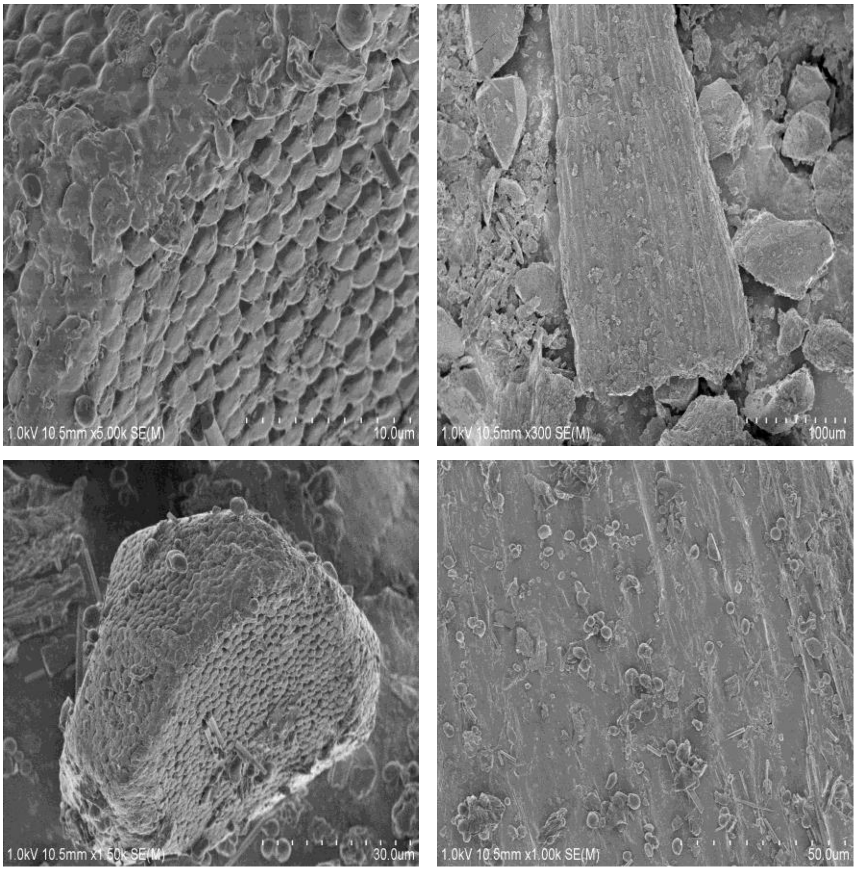
Data are expressed as mean ± SD (n = 3).
H/F=alhydwan flour,WF= Wheat flour

Table 2. Effect of addition alhydwan flour on the freshness (%) of bread stored at room temperature.

	Storage time (hrs)								
	at zero time	8	Loss of freshness %	24	Loss of freshness%	48	Loss of freshness %	72	Loss of freshness %
Control	416.26	398.44	4.28	352.03	15.43	298.67	28.25	282.02	32.25
H/F %5	394.92	363.35	7.99	312.31	20.92	283.55	28.20	275.54	30.23
H/F %10	410.14	283.15	6.58	338.28	17.52	307.61	25.00	301.33	26.53
H/F %15	433.77	414.99	4.33	367.79	15.21	347.02	20.00	335.99	22.54

Data are expressed as mean ± SD (n = 3).
H/F=alhydwan flour,WF= Wheat flour

Fig. 1. Scanning electron microscopic (SEM) pictures of whole alhydwan seed flour. l



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