



Original article

## Effect of Extraction Rate of Flour on Consumer Acceptance and Attitude Towards Pocket – Forming Bread

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### Abstract

Freshly baked, two pocket breads, prepared from whole wheat (WWF) and straight grade wheat flours (SGWF), were purchased from a local bakery in Amman / Jordan in the month of September / 2023. Sensory quality of the two breads was evaluated by 46 trained-member taste panel for the quality parameters used for evaluation of bread in general, and this bread type in particular, including general appearance, texture, crumb and crust color, taste and flavor, pocket formation, rolling and folding and overall acceptance. Willingness of the panelists to pay for the two bread types was also evaluated by asking them whether they would buy each bread type. Results showed that there was no significant ( $P < 0.05$ ) difference between the two bread types in all quality attributes, except the mouth feel, smoothness and softness of the texture and pocket formation where SGWF bread had higher scores than WWF bread. WWF bread, on the other-hand, had higher score than straight-grade bread with respect to rolling and folding. The panelists showed significantly more favorable attitude towards buying the WWF bread as compared to the SGWF type.

**Keywords:** Whole Wheat Bread, Dietary Fiber, Sensory Quality, Consumer Attitude, Flat Bread

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## **INTRODUCTION**

Dietary fiber with its unique physicochemical characteristics, including ability to bind water and bile acids, has well established health benefits including lowering the incidence of cardiovascular diseases (Bazzano, 2008; Packkia-Doss et al., 2019; Singh et al., 2019), stroke and type II diabetes (Slavin, 2004; Jones et al., 2006), and risk of cancer ( Slavin et al.,2000a & b). Its ability to delay gastric emptying and increase satiety and fecal mass (Aktas-Akyildiz, 2020) helps prevent constipation, diverticulosis and colorectal cancer (Lairon et al., 2005; Whent et al., 2012; Song et al., 2015). Concerned organizations including WHO and some local governments recommended the consumption of 2-3 whole- grain servings/ day to achieve the desired health benefits (Ferruzzi et al., 2014; UCSFHEALTH, 2023). Consequently, in light of worldwide increased health awareness of these benefits, production and consumption of high- fiber foods have been on the rise (Whitney and Simsek, 2017) especially in the Mediterranean countries where consumers are accustomed to fiber – rich diet.

Wheat, in the form of bread and other products, is the staple food of many nations around the world (Johnston et al., 2019) including Mediterranean countries in general and Arab countries in particular, where flat pocket- forming type is the most popular and supplies a high percentage of the daily caloric intake (Amr and Ajo, 2005; Levent and Bilgicli, 2012;Georges et al., 2018; Al-Jawaldeh and Al-Khamaiseh,2018) especially in the Levant and Egypt. Therefore, this bread type would be the carrier of choice of dietary fiber in these countries, a goal achieved by consumption of whole-wheat bread, or by the addition of wheat bran to the bread formula.

Wheat bran and germ are packed with vitamins, protein, minerals and fiber (Piironen et al.,2009; Balandrán-Quintana et al.,2015). Hence, the process of flour refining by removal of germ and various levels of bran, represents, a nutritional loss of these nutrients depending on the amount of bran removed ( Barros et al.,2010), albeit it results in desirable chemical and physical properties of the refined flour and improved sensory properties of the bakery products (Zhang et al., 1999; Curti et al., 2013).

Wheat bran was used by a number of researchers in order to enhance the sensory and nutritional quality of bakery products such as bread, cakes and others (Mert et al.,2014; Onipe et al.,2015; Cheng et al., 2022). Its effect on bread quality has been the subject of a number of studies: Yangilar (2013) reported that addition of wheat bran improved the physical and sensory properties associated with baked products. Almeida et al. (2013), who used many habitual bran- bread consumers in their taste panel, concluded that dietary fiber from different sources had a considerable positive influence on acceptance of crumb and crust color, and texture of pan bread. Feili et al. (2013) also showed that incorporation of different levels of dietary fiber in bread formula resulted in improvement of texture and volume of pan bread. Gómez et al. (2020) reported that addition of dietary fiber to pan bread dough not only extends the shelf-life of the product, but also significantly enhances both qualitative and sensory properties of bread. On the other hand, other workers (Almeida et al., 2010;

Majzoobi et al.,2013; Hemdane et al., 2016; Li et al.,2023;) highlighted the negative effect of bran on the physical properties of the dough as it causes its slackness due to gluten dilution and increased water absorption which require more attention by bakers. Furthermore, addition of bran to cereal foods, has a negative impact on some sensory and nutritional properties of such foods thus resulting in their rejection by some consumers due to their organoleptic characteristics especially making the crumb too harsh for some consumers (Hassan et al.,2008; Hemdane et al.,2016; Ozkaya et al., 2018;Rezaei et al.,2019; Doan et al.,2021;) and with unpleasant taste ( (Tabben and Li,2019) let alone its antinutrient content mainly phytic acid and tannins( Hassan et al.,2008) which bind nonheme iron and other divalent ions, and its effect on gastrointestinal health and bloating(Hebden et al., 2002;Samy et al., 2017).

The majority of bread marketed in Jordan, a typical Arab country due to its geographic location, is produced from 75% extraction straight – grade flour (Amr,1988). However, the rising demand on the WWF, high- fiber products, due to the above-mentioned reasons combined with improved health awareness and proliferation of nutrition knowledge, has prompted most mills and bakeries to produce higher extraction flour and bread to meet the growing demand on high-fiber bakery products. However, despite its benefits, many consumers especially younger ones, still refrain from consuming high -fiber bread and prefer the more refined bread.

The objective of this study is to elucidate the differences in sensory attributes between two types of flat pocket – forming Arabic bread (SGWF and WWF ), by a group of Jordanian trained tasters under controlled conditions. Their attitude towards the two breads as measured by their willingness to purchase each type was also evaluated.

## **MATERIAL and METHOD**

**Bread Samples:** Freshly baked SGWF and WWF, pocket -forming Arabic ( Kmaj ) bread samples were purchased from the same local bakery within 3-4 hours of baking in two different batches. Both SGWF and WWF were prepared from straight grade (75% extraction) and whole wheat (95% extraction) flour respectively, milled from hard red winter wheat. The two bread samples were produced on the same day following the same Straight Dough baking procedure ( Amr,1988) with lean formulas consisting of flour, salt( 1% ) , yeast( 2%) and water( 53-57%) . The only difference between the two formulas was in the flour extraction and water absorption needed to reach the proper consistency as judged by the master baker. The doughs underwent bulk fermentation, punching two times, dividing, sheeting, and proofing in a proofing cabinet before baking at 450°C/ 50 seconds ( Amr, 1988). The baked loaves were cooled at ambient temperature, kept in polyethylene bags and brought immediately to the Sensory Evaluation Laboratory of the Jordanian National Sensory Evaluation Society where each loaf was divided into four quarters.

**Taste Panelists:** The study was approved by the Ethical Committee, the University of Jordan: EMNMH 2219136 T: 3.1 A: 74173/2023. Human testing was conducted after oral consent was taken

from each participant. Fifty volunteer panelists (16 males, 34 females, aged between 24 and 75 years old) were trained on sensory evaluation of pocket bread in November / 2023. They received two, 3-hour training sessions on the general aspects of organoleptic analyses and in-depth sensory evaluation of Arabic flat bread (Amr,1988;Elía, 2011). The training sessions were held by the Jordanian Society of Sensory Evaluation for Food. Analysis of Variance followed by Least significant Difference (LSD) test was performed on the responses of the volunteers to the overall acceptance of the bread by the end of the training sessions, and those with significantly different responses (four of them) to this attribute were excluded from the taste panel, thus only 46 panelists remained ranging in age between 24 and over 70 years ( Table 1).

**Table 1.** Age distribution of the panelists participating in the sensory testing of the SGWF and WWF bread.

Age ( years)	Frequency
24-29	14
30-49	12
50-59	14
60-69	2
70 and above	4

SGWF= straight grade wheat flour, WWF= whole wheat flour.

All panelists confirmed they had no known gluten allergy, celiac disease or wheat-related health disorders, and all were recognized as regular bread consumers. All were recruited by direct approach and asked to participate in the sensory evaluation test depending on their willingness to take part in the study and the frequency at which they consume Arabic flat bread.

Taste panel settings: The tasters were seated in separate booths, under day light (10-11:0 am), and provided with water for washing their mouths after tasting each sample. Samples were randomly assigned with 3-digit codes to each panelist, where a quarter of each loaf of each bread sample (WWF or SGWF) was served on white, odorless, and disposable polystyrene plates at room temperature. The panelists were asked to evaluate each sample for thirteen quality attribute descriptors of ten major quality attributes (Elía, 2011) (table 2) and assign an overall score, after explaining these attributes during the training sessions. A form was designed to evaluate acceptance of each sample by panelists on 1-9 scale with dislike extremely (1); dislike very much (2); dislike moderately (3); dislike slightly (4); neither like nor dislike (5); like slightly (6); like moderately (7); like very much; (8) like extremely (9). The Attitude toward the two bread types was evaluated by the willingness of the participants to buy the bread by filling a form that asks them to answer five questions on a scale of 1-5 ( Agree strongly, Agree, neutral, disagree and disagree strongly) elaborated in the results and discussion section.

**Table 2.** Major quality attributes of the flat bread and their descriptors

Quality attribute	Attribute descriptors
General appearance of crust and crumb.	Crumb color, crust color,
Texture by gustation	Softness, tenderness, stickiness ( adhesion to mouth).
Crumb color	White shiny grain
Grain	Uniform velvety
Taste	Saltiness, sweetness typical of fresh flat bread.
flavor	Typical of freshly baked bread.
Mouthfeel	Smoothness
Pocket formation	Separation of the two layers.
Rolling and folding	Crumbliness and cracking upon folding and rolling.
Overall acceptance	As perceived by panelist.

Data analysis: Data was tabulated and the averages and standard deviations for each attribute were calculated. Analysis of Variance followed by Least Significant Test (LSD) (SPSS /IBM, 2017) was used to exclude tasters with different responses from the other members of the panel. Chi square test (Whatley, 2022) was used for analyzing the discrete categorized data describing the attitude of the panelists towards the bread types and the results of the sensory evaluation.

## RESULTS and DISCUSSION

### Crust and Crumb Characteristics:

Crust color of the bread is the result of both Maillard and caramelization types of browning reactions during baking (Purlis, 2010). However, since a sugar-free, lean formula was used in the production of this bread, the brown color is due to the naturally present sugars (Struyf et al., 2017) in the two flours used. Table 3 shows the average sensory scores of the attributes related to the crust and crumb as evaluated by their colors and the grain of the crumb. Scores for these quality factors were not significantly ( $P \leq 0.05$ ) different between the two bread types, although WWF bread was given higher color scores than purified SGWF bread despite the lighter color of the latter, but lower grain scores. Preferring the darker crumb is due to the mindset of the panelists which associates darker color with healthier bread (Barrett et al., 2020), although crumb darkness is known to lower the score of pan bread (Valjakka et al., 1994). Crumb structure and texture are more important quality parameters for pan than pocket bread (Ishida and Steel, 2014; Borsuk et al., 2021) although both types should have a velvety-dry crumb. However, crumb grain of the purified pocket bread, albeit much less in proportion than that of pan bread, was velvety with more uniform, smoother cells as compared to the more open cells of the WWF bread. Large open-cells property of the grain is due to the higher amounts of moisture retained by the bran particles (Curti et al., 2013). Crust color and appearance are some of the most important sensory quality attributes of bread (Paladugula et al., 2021). Similar to pan bread, a golden to light brown crust color is desired for pocket bread (Castro et al., 2017). Unlike pan bread, which has a

remarkable amount of Break and Shred (Basha,2007) ) due to oven spring; pocket type of bread does not show this phenomenon which results from the expansion of the fermentation gas during the early stage of the baking step in what is known as oven rise or oven spring, although it can be observed in the crumb-rich Hamam type of Arabic bread ( Amr,1988).Break and Shred is one of the important sensory characteristics of pan and other high-crumb breads.

**Table 3.** Means of the sensory testing scores of the bread quality attributes

Quality attribute	Mean $\pm$ SD, SE		p-value*
	SGWF	WWF	
Crust color	6.96 $\pm$ 1.44 ,0.21	6.98 $\pm$ 1.32,0.19	0.942
Crumb color	7.07 $\pm$ 1.54 ,0.22	7.13 $\pm$ 1.19,0.17	0.821
Grain	6.91 $\pm$ 1.43 ,0.21	6.67 $\pm$ 1.10,0.16	0.370
Pocket Formation	7.78 $\pm$ 1.17 ,0.17	7.43 $\pm$ 1.54,0.23	0.227
Mouth feel Smoothness	8.07 $\pm$ 0.95 ,0.14	6.80 $\pm$ 1.13,0.17	<0.001
Taste/sweetness	6.41 $\pm$ 1.60 ,0.23	6.48 $\pm$ 1.62,0.24	0.846
Taste/saltiness	6.33 $\pm$ 1.43 ,0.21	6.74 $\pm$ 1.39,0.20	0.164
Flavor	6.50 $\pm$ 1.52 ,0.22	6.70 $\pm$ 1.35,0.20	0.515
Rolling and Folding	6.33 $\pm$ 1.38 ,0.20	6.35 $\pm$ 1.84,0.27	0.949
Texture/softness	7.00 $\pm$ 1.38 ,0.20	6.37 $\pm$ 1.37,0.20	0.031
Texture/tenderness	7.24 $\pm$ 1.20 ,0.17	6.83 $\pm$ 1.35,0.20	0.125
Texture/adhesion	6.30 $\pm$ 1.85 ,0.27	6.78 $\pm$ 1.65,0.24	0.193
General acceptance	7.17 $\pm$ 0.93 ,0.14	7.09 $\pm$ 1.19,0.18	0.697

\* p-value<0.05, SD: Standard Deviation, SE standard error. n= 46.

SGWF= straight grade wheat flour, WWF= whole wheat flour.

As shown in tables 3&4, there were no significant differences between the two bread types in their crust color scores. Scores of these quality attributes were not different between the two bread types. High extraction flour has more natural sugars than purified flour (Carocho et al., 2020) which contributed to the more appealing crust color of the WWF bread.

Similar to crust color, crumb color of both breads was not significantly different (  $P \leq 0.05$ ) as perceived by the panelists, although WWF bread was slightly preferred over the SGWF (Table 3 ). Crumb color is influenced by the degree of flour purification; high extraction flours have more bran particles that reduce the color scores by some consumers. Crumb grain is of less importance in this type of bread than in pan bread due to the function flat Arabic bread plays in a typical meal which includes dipping and spooning as well as holding of food in the formed pocket ( Amr, 1988); both functions do not require fine uniform grain as in case of pan bread slices where sandwiches are made by placing the food between two free slices. Crumb grain has less effect on the perception of the bread in the former case, yet a higher but nonsignificant (  $P \geq 0.05$ ) number of panelists gave the SGWF bread a higher score than the WWF bread (Table 3). Bread type has no significant (  $P \leq 0.05$ ) effect on crumb and crust characteristics as perceived by the panelists under the conditions of this trial.

### **Pocket Formation and Rolling and Folding:**

Rolling and folding are unique properties to pocket forming and some other thin flat breads (Suchintita et al.,2023 ). These two properties are inversely related to the amount of crumb, which in turn affects the specific volume of bread. While pocket forming flat bread has a very low specific volume ( 1,2 cm<sup>3</sup>/g)( Amr,1988) pan bread has a much higher specific volume ( $\geq 4.0$  cm<sup>3</sup>/g)( Borsuk et al.,2021) which makes it hard to roll and fold and thus easier to slice for sandwich preparation. Sudden steam production inside the loaves as a result of high baking temperature (about 450°C) is responsible for puffing and layer separation of the pocket bread. Puffiness of loaves disappears upon cooling to end up with two paper-thin separable, layers of the pocket bread. These two properties of flat bread, enable consumers to make sandwiches by placing cooked food within the two connected layers of the loaf, which made them gain worldwide popularity especially for making the two Arabic delights, Falafel and Shawerma sandwiches. SGWF bread had higher, though non-significant (Tables 3) average scores than WWF bread in pocket formation, although the latter scored higher by the panelists in rolling and folding. This is due to the fact that bran in the WWF bread retains more moisture (Curti et al., 2013) thus making the bread moister and harder to form pockets, but more elastic and easier to fold.

### **Taste and Flavor**

Taste was described by panelists by mouthfeel, sweetness and saltiness. The mouthfeel of SGWF white bread was the only highly significant (  $P \leq 0.001$ ), preferred attribute over that of WWF bread (Tables 3). This is due to the harshness imparted to the WWF bread by the bran particles. Harshness was reported to be a problem with the WWF pan bread (Hemdane et al., 2016 ). Tebben &Liu ( 2019) reported that bran has a negative effect on bread palatability as perceived by the mouthfeel. Sweetness of the bread, although no sugar was added is caused by the natural sugars present in the flours; there was no significant difference between the two bread types with regard to this quality criterion. As both breads had only 1% salt in their formulas, there was no significant difference between them with regard to saltiness, although WWF bread had higher (though non-significant) average score than white bread (Table3). Based on the average scores (Table 3), the flavor of the WWF bread was preferred, though non-significantly, over that of the SGWF bread.

Texture: The texture of the two bread types was evaluated by the softness and tenderness of the crust, and moistness of the crumb. SGWF bread was significantly (  $P \leq 0.05$ ) softer ( Table 3), non-significantly more tender, but drier than WWF bread. Water retention by bran particles is responsible for these differences (Curti et al., 2015). Crust of freshly baked pan bread is crisp in texture (Al -Hebeil, 2013), while that of fresh pocket bread is softer, leathery and chewier after cooling unless overbaked, which makes it more flexible and easier to apply food spreads on, even without toasting.

### Overall Acceptance:

SGWF white bread was scored higher, though non-significantly, than WWF bread (Tables 3). This is natural due to the better organoleptic characteristics of the white bread. Despite its superior overall quality consumers preferred buying WWF (Table 4) due to its health benefits.

### Attitude Questions

At the end of the sensory evaluation session, the panelists were asked about their attitude towards the two bread types by asking them the questions in table 4.

**Table 4.** Attitude of panelists towards WWF vs SGWF bread

Degree of agreement	I buy the WWF even if its price is higher than SGWF.	I buy WWF bread only if it was cheaper than SGWF.	I buy WWF bread if its price the same as the SGWF.
Agree strongly	16%	4%	28%
Agree	46%	4%	28%
Neutral	18%	20%	16%
Disagree	16%	50%	26%
Disagree strongly	4%	22%	2%

SGWF= straight grade wheat flour, WWF= whole wheat flour.

As shown in table 4, 62% of respondents answered that they will buy the WWF bread even if its price is higher than SGWF bread. The 20% which disagreed believe in its benefits, but are not willing to pay more for it. It is noteworthy, to say that SGWF bread is government - subsidized in Jordan (Tabaza, 2020) which makes its price lower than all other bread types including the WWF type. When asked if you buy WWF bread if it is cheaper, only 8% agreed compared to 72% of respondents disagreed and said that they still buy the WWF bread even though its price is higher. If the two bread types were equal in price, 56% of respondents preferred the WWF bread.

### Conclusion and Recommendations

Sensory evaluation of SGWF and WWF breads by Jordanian consumers revealed that SGWF bread was more palatable, softer, more tender, better pocket former, but drier than WWF bread which had a harsh mouthfeel yet superior in its rolling and folding characteristics. SGWF type was preferred to the WWF type in the general acceptance quality attribute. However, attitude of consumers as evaluated by their willingness to buy the two bread types showed that they still would buy the WWF bread despite its inferior sensory quality due to its health benefits. However, due to study limitations regarding the conditions of bread production, It is recommended to carry out further controlled studies on the effect of a series of extraction- rate wheat flours, and other fiber sources, on the sensory and nutritional qualities, and consumer acceptance of pocket bread. A Knowledge, Attitude and Practice (KAP) study of the high extraction bread on a larger segment of consumers is also recommended.

## **Additional Declaration**

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