JOURNAL OF AGROBIOTECHNOLOGY 2021, VOL 12(2):97-107
e-ISSN: 2180-1983
http://dx.doi.org/10.37231/jab.2021.12.2.252
https://journal.unisza.edu.my/agrobiotechnology/index.php/agrobiotechnology/index

# Effects of Processing Technique on Physical and Organoleptic Properties of Whole Meal Bread

Nur Amalia Abdullah, and Noroul Asyikeen Zulkifli*

[a] School of Food Industry, Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin, Besut Campus, 22200 Besut, Terengganu Darul Iman, Malaysia.

***Corresponding author: asyikeenzulkifli@unisza.edu.my**

*Received: 06/08/2021, Accepted: 18/09/2021, Available Online: 16/11/2021*

***ABSTRACT***

Whole meal bread made up from whole grains mostly consumed due to health purpose. The aim of this study was to determine the effect of processing technique on physical (colour, moisture content, pore size, texture and specific volume) and organoleptic properties of whole meal bread. Three treatments which B1, B2 and B3 of whole meal bread were prepared which represent the processing technique straight dough, sponge and dough, and sourdough, respectively. Whole meal bread between B1 and B2 with B3 showed significant ($p < 0.05$) increased in density (276.58, 270.35, 647.84 g/cm$^3$), hardness (747.16, 747.16, 2425.75 g/cm$^3$) and chewiness (495.71, 519.98, 2843.73 g) respectively. Variations were observed for crumb (internal) and crust (external) colour from 33.77 to 39.63 (L-value), 3.08 to 9.80 (a-value) and 25.38 to 10.82 (b-value), 23.65 to 27.94 (L-value), 2.27 to 2.95 (a-value), 9.26 to 13.11 (b-value) respectively. Hence, straight dough method produced whole meal bread with higher value of specific volume (3.58 cm$^3$/g), moisture content (24.66 %), lightness of crumb (23.65) and chewiness (495.71 g). Thus, results showed that straight dough method was the most efficient and acceptable method for bread baking process in order to get the good physical and organoleptic properties of whole meal bread.

**Keywords: whole meal bread, processing technique, sourdough, straight dough, sponge and dough.**

## INTRODUCTION

Wheat-based food products are highly consumed due to its important sources of energy, proteins, carbohydrates, fibre, minerals, phenolic acids, vitamins, and other bioactive phytochemicals (Lu et al., 2014). For several years ago, bread has been part of human daily diet. Traditionally, baked products are produced using wheat flour especially bread (Oladunmoye et al., 2010). It is made from cereals grain, for example, wheat, rye, oats and the nutritional composition depends on the type of flour used to produce the bread rather than the differences method of making. Daily consumption of whole grain and high fibre products was desired to be significantly higher for the health reasons. Hence, the inclusion of processing method on the dough can be considered to improve the quality of whole meal bread. Bread was widely consumed throughout the world as become the first global consumption due to good source of carbohydrate and low in fat content. Epidemiological studies have shown that consumption of whole grains provides a protective effect against chronic health conditions such as cardiovascular disease, type 2 diabetes, and certain forms of cancers (Lu et al., 2014). The exact mechanisms for the health beneficial properties of the whole grains have not been completely determined; however, it was thought that the higher amount of the bioactive phytochemicals in whole grains may play an important role in these benefits (Lu et al., 2014). Bread generally can be made from various types of method such as straight dough method, sponge and dough method and sourdough method. Sourdough was one of the traditional forms of cereal fermentation utilized primarily for baking purposes especially bread making as it helps the dough to leavened and produced oxygenate bread. The use of sourdough in wheat breads has gained popularity as a means to improve the quality and flavour of wheat breads (Arendt et al., 2007). In recent years, more organic, tasty and healthy sourdough bread production has gained tremendous success with increasing demand by the consumers (Behera & Ray, 2016). Straight dough method was a one-step process which all the dough ingredients are added together and mixed in a single batch causes lower processing of time, power and equipment. Generally, straight-dough bread was chewier than bread made by other techniques as it has a coarser cell structure but also considered to have less flavour (Balestra, 2009). The sponge and dough methods were basically developed to ensure homogenous ingredient dispersion and flour hydrations where it involves two mixing stages, one for the sponge and the other for the dough. The quality factors for bread include the colour, texture, flavour, baking quality, the presence or absence of nutritive value during preparation and extended storage.

High volume, soft and elastic crumb structure, good shelf-life and microbiological safety were the main important quality characteristic of wheat bread product (Cauvain, 2003). Unfortunately, wheat bread was a perishable product where starts to deteriorate immediately after baking. Bread becomes stale largely because of the physical changes that occur in the starch-protein matrix of the bread crumb (Katina, 2005). Organoleptic properties include colour, odour and texture were important parameters used to determine taste preference among consumers (Decock & Cappelle, 2005). Physical analysis may help validate differences between whole meal bread made up from different techniques and determine if a preference exists. Food and Agricultural Organization (FAO) policy determines that alternative wheat flour from local sources is important nowadays. Since quality value of bread has been linked with its physical properties, the current study was designed to investigate the effects of straight-, sponge and sour-dough bread making processes on physical and organoleptic properties of whole meal bread.

The processes manage in the food industry primarily change the state of ingredients due to effect on the physical, chemical, thermal and biological properties of the foodstuffs. The changes include expansion of materials, textural strength and some of the quality factors are particle size, colour, flavour, protein content, fat content and moisture content (Oladunmoye et al., 2010). Whole meal bread was highly desirable by people due to the production of bread from blends of whole wheat flour and flour from locally four produced crops (Inyang, 2016). The information obtained from this study might be able to provide the best method that can be used to produce good quality of whole meal bread with better organoleptic properties. Different processing method of whole meal bread will be influenced the nutritional valued, thus the best quality of whole meal bread can be determined through this study. Thus, the aims of this study were analysing the physical properties and evaluate the organoleptic properties of whole meal bread processed using different processing methods.

## MATERIALS AND METHODS

### Raw Materials

Whole meal (wheat) flour was the main raw material that had buy from nearest groceries or supermarket. The other ingredients that needed for whole meal bread making were yeast, salt, sugar and fat that also had be bought from bakery shop in Jerteh, Terengganu.

**Formulation of Whole Meal Bread**

Whole meal bread had been prepared using three processing method as shown in Table 1. Trial experiments were made to get suitable combinations for composite bread making.

**Table 1**. Formulation of whole meal bread

| Ingredients | B1 | B2 | B3 |
|---|---|---|---|
| Whole meal (wheat) flour (g) | 117 | 117 | 100 |
| All-purpose flour (g) | 117 | 117 | 100 |
| Instant dry yeast (g) | 3 | 3 | - |
| Starter culture (g) | - | - | 75 |
| Salt (g) | 1 | 1 | 3 |
| Sugar (g) | 25 | 25 | - |
| Fat (g) | 21 | 21 | - |
| Water (ml) | 118 | 118 | 124 |
| Total (g) | 402 | 402 | 402 |

Source: (Oladunmoye et al., 2010)
B1: Whole meal bread treated with straight dough method
B2: Whole meal bread treated with sponge and dough method
B3: Whole meal bread treated with sourdough method

**Preparation of Whole Meal Bread**

The preparation of the whole meal bread had been done in the bakery laboratory by using three different processing methods which were straight dough method, sponge and dough method and sourdough method.

*Straight Dough Method*

In straight dough method, all ingredients had been mixed together. The dough was kneaded and shaped then was left in the tray for bulk fermentation at the ambient temperature. Dough formation for bulk fermentation had been carried out by low-speed mixing machines where the amount of energy was imparted to the dough was very small by comparison with other types of breadmaking processes.

*Sponge and Dough Method*

The most popular baking process was sponge and dough procedure that involves two-step process. The sponge was made by mixing a part of the total flour with yeast, sugar (as yeast food), and water. Then, the sponge had been allowed to undergo first fermentation. In the second step, the fermented sponge had been mixed with the rest of the flour, water and fat until form a dough. Next, the dough had been kneaded and shaped into small ball shape before undergo proofing, baking and cooling.

*Sourdough Method*

In sourdough method, the leavening agent used was different from others method as it produced traditionally including two stages of fermentation. The starter culture (naturally fermented flour and water mixture) made initiated sourdough fermentation. The food available for the organisms becomes limited with increasing of time however, as new flour and water were added and the "starter culture" was fed or rebuild, the bacteria become more predominant. Making sourdough bread was often long, of the order of several days due to factors such as temperature and moistness of surrounded environment.

**Psychochemical Analysis of Whole Meal Bread**

*Moisture Content Analysis*

For the moisture analysis, had been determined by using Moisture Analyzer (MA-35, Sartorius). Firstly, the whole meal bread sample was ground by using dry mill blender. For about 3 g of whole meal bread sample was distributed evenly on the aluminium sample pan before the analyser started heating to the drying temperature of 105°C for about 15 minutes. The loss in weight was assumed as percentage of moisture. All the tests were conducted for triplicates and average reading of the sample was calculated and recorded for further calculation of moisture content.

*Texture Profile Analysis (TPA)*

Texture profile analysis (TPA) of whole meal bread was carried out by using a TA-XT2 Texture Analyzer (Stable Micro System Co. Ltd, Surrey, England) 1 hour after baked. Firstly, texture analyser was calibrated with 5 kg load cell and a cylindrical probe of 36 mm in diameter was attached to the crosshead. The whole meal bread was cut into slices of 3 cm thick and placed at centre of texture analyser machine and the probe head was adjusted until touched the surface of bread sample. The samples were measured by compressing 25% of their original height with duration of 40 seconds of evaluation. The textural properties (hardness, gumminess, chewiness, springiness, cohesiveness and resilience) of whole meal bread were extracted from the curved obtained. The tests were conducted for triplicates and average value was calculated and recorded.

*Specific Volume and Density Analysis*

The volume of the whole meal bread was determined by using VolScan Profiler machine (VSP 600: Stable Micro System Ltd., Surrey, UK). The VolScan Profiler was a laser-based instrument be used to get accurate volume of bakery products. The product was mounted at each end by a suitable mounting device tailored to the specific product. Parameters has been entered into the software for each batch under test included the sample ID name, sample weight, bread type and batch code. The results were obtained in a period ranging from a few seconds and the assessment was done rapidly. During this analysis, the product was automatically weighed and an eye-safe laser device scanned vertically to measure the contours of the product at selectable intervals whilst the product rotated. When the test was completed, the volume, length, maximum width and maximum height was determined. By dividing bread weight (g) with volume ($cm^3$), the density ($g/cm^3$) was derived and recorded in table.

*Pore Size Analysis*

The pore size of the sample had been determined as to identify different types of method in bread making influence the pore size of the bread. Crumb cell characteristics been analysed by using ImageJ system. The images of the cross sectional for three types of bread were identified as to compare the pore size of the bread. In order to do particles analysis effectively, all images been taken at the same magnification with similar contrast. The image was opened by using ImageJ. The scale for the image setup by selecting the 'Analyse' on the menu, then 'Set Scale' was selected and units for the scale was entered. The image then was converted into 8-bit binary segmentation was selected form black and white threshold image. By using a box tool, the region interest on the image with the particles desired to be analyse was selected. Images were saved in a Tagged Image File Format (TIFF) and the software was used to calculate the percentage of pore area in the whole area of the examined slice which was the porosity.

*Colour Analysis*

Whole meal bread sample colour for crust and crumb had been measured based on the CIE L*, a* and b* system using a Konica Minolta CR-400 Chromameter (Castro et al., 2017). The equipment firstly was calibrated by using white ceramic tiles. The colour of the crust been measured at the surface of the whole meal bread while the colour of crumb been measured at the centre part of crumb after the bread was cut into half pieces. The colour was described as L* a* b*, where L* defined the lightness ($0^{0}$ = black, $100^{0}$ = white), a* indicated the red or green value (+ value = redness, - value = greenness) and b* was defined as the yellow or blue value (+ value = yellowness, - value = blueness). The entire test been conducted for duplicates and average value have been recorded.

**Organoleptic Analysis of Whole Meal Bread**

The 7-point hedonic scale test was used to determine sensory acceptability of sample by panellists in which scale 1 indicates extremely dislike to 7 indicates extremely like. Forty panellists from students of Universiti Sultan Zainal Abidin (UniSZA) were selected to evaluate and rate the three sample of whole meal bread. The sample were served in plastic plate code with 3-digit random numbers. The attributes that had been evaluated were colour, taste (mouth-feel), flavour (aroma), texture and overall acceptability using seven-point hedonic scale. All data generated were subjected and been analysed using statistical analysis.

**Statistical Analysis**

Analysis of Variance (ANOVA) was conducted using SPSS 20 Generic Linear Procedure (SPSS inc., USA). The mean values had been identified using One Way Analysis of Variance (ANOVA). Duncan's multiple range tests with significant level ($p<0.05$) was used to compared the significance differences among the sample.

## RESULTS AND DISCUSSION

**Effect of Processing on Specific Volume and Density of Whole Meal Bread**

Volume was an important issue in the processing of food product, which can correlate to the density of food specifically on the bread crumb and the gluten strength in the flour (Ibrahim et al., 2020). The volume of the bread depends on the number and size of air bubbles within the bread and also the density of the crumb surrounding the air bubbles (Trinh et al., 2016). Bread crumb structure was one of the major quality attributes of bread. Formation of bubbles in dough is caused by increasing amount of carbon dioxide ($CO_2$) which related to gas-holding capacity that affects the specific volume of the final product. To ensure optimum desirability of bread volume measurement, the Volscan Profiler, a laser-based instrument be used to get accurate product volume.

From Table 2, there was a significance difference ($p < 0.05$) between B3 and the other two sample (B1 and B2) but there was no significant difference ($p < 0.05$) between B1 and B2. The values for specific volume range from $1.48 \pm 0.12$ $cm^3/g$ to $3.71 \pm 0.11$ $cm^3/g$. Since the bread samples studied have been produced from the different mixing, proofing and baking time, the variation in sample volume could be attributed. B1 and B2 bread have significantly higher specific volume than B3 bread. The increase in the specific volume of breads of sponge and dough method may be due to the improvement brought by extensibility of the dough (Ibrahim et al., 2020). The specific volume was stated as $cm^3/g$ of the bread while density was stated as $g/cm^3$ of the bread. The porous structure allows a release of pressure and a consequent contraction and increased density of the bread. Gelatinisation of starch change from a viscous liquid to an elastic, or effectively rigid, solid results in the change in density being fixed (Jefferson et al., 2007).

From the results shown in Table 2, there was no significant difference ($p < 0.05$) between samples B1 and B2 for density, but B3 has significant different between the samples. The range values for density were from $270.35 \pm 7.83$ $g/cm^3$ to $647.84 \pm 15.13$ $g/cm^3$. Bread sample of B3 shows significant difference ($p < 0.05$) with B1 and B2 bread as it has lower value of specific volume but higher value of density. The B3 bread sample have more compact bread structure and denser in crumb compared to other bread sample. The decreasing specific volume, the more compact the bread as the gas-producing ability of sourdough organisms was lower than yeast (Balestra, 2009). Wheat bread prepared with sourdough method has a denser loaf with lower volume, sour-aromatic taste and prolonged shelf life (Balestra, 2009). Based on Table 2, it can be stated that specific volume was inversely proportional with density of all the whole meal bread sample. Density was the inverse of specific volume and it gave extensive effect on bread crumb, which means that when density increased, the specific volume been decreased (Scanlon & Zghal, 2001).

**Table 2.** Effect of processing on specific volume, density and moisture content of whole meal bread

| Parameter | B1 | B2 | B3 |
|---|---|---|---|
| Specific Volume ($cm^3/g$) | $3.58 \pm 0.03^b$ | $3.71 \pm 0.11^b$ | $1.48 \pm 0.12^a$ |
| Density ($g/cm^3$) | $276.58 \pm 6.48^a$ | $270.35 \pm 7.83^a$ | $647.84 \pm 15.13^b$ |
| Moisture Content (%) | $24.66 \pm 1.53^a$ | $26.39 \pm 0.86^a$ | $25.27 \pm 4.51^a$ |

*mean ± standard deviation
Means in the same row with different superscript are significantly different ($p < 0.05$)

### Effect of Processing on Moisture of Whole Meal Bread

Moisture content related with the freshness and stability for a long period of food storage (Ibrahim et al., 2020). Moisture in bread was important because moisture helps to moisten and lubricate the bread and potentially helps in slowing down the crumb firming process. Bread has high moisture content in baked crumb and lower moisture content in crust (Cauvain & Young, 2012). Table 2 shows the effect of processing on moisture content of whole meal bread. As shown in Table 2, the values range from 24.66 ± 1.53% to 26.39 ± 0.86%. There was no significant difference ($p < 0.05$) in moisture content of B1, B2 and B3 bread sample. Due to constant baking time with higher baking temperature, higher moisture in bread crumb can be retained where else increasing baking time reduces moisture in crumb. This may cause by the fibre content in whole meal bread that could absorb water that does not evaporated during the baking step caused high moisture content. Moisture loss can occur through process of drying out during storage and equilibration of moisture between crust and crumb. When moisture decreases, it accelerates the formation of crosslinks between starch and protein that cause the bread become firms faster. The acceptable range of moisture content of normal bread was between 25-40% for one day storage (Ibrahim et al., 2020). During storage, high initial moisture content bread has slower moisture loss during storage cause retards firming of bread crumb (Park et al., 2005).

### Effect of Processing on Colour of Whole Meal Bread

Time and temperature of baking highly affect the crust colour of bread (Zhou, 2014). The components of the ingredients used in the formulation are also important. Table 3 shows the effect of processing on crust and crumb of whole meal breads. The value for L* represent lightness. Then, a* value defines the redness or green value (+a* value indicates red colour while -a* value indicates green colour). The b* value defines the yellowness and blueness value (+b* value indicates yellow colour while -b* value indicates blue colour). Based on Table 3, the L* value of crust for all samples were higher than crumb as it shows that the crust was lighter than the crumb. The values of a* and b* for the three sample in crust were higher compare to crumb.

The darkening of crust colour was attributed to the higher rate of the Maillard reactions between reducing sugars and proteins (Kunyanga & Imungi, 2010). The sugars and breakdown products of proteins released from the enzyme activity are then available to sweeten the bread crumb and participate in Maillard or nonenzymatic browning reactions, which are responsible for the brown colour of the crust (Rosell, 2011). As shown in Table 3, there was no significant difference ($p < 0.05$) in L* value (lightness) of crust colour between B1, B2 and B3 with the values range from 33.77 ± 9.76 to 39.63 ± 8.53. However, there was significant difference ($p < 0.05$) in a* value (green colour) and b* value (yellow colour) of crust colour between B3 towards B1 and B2 bread with values range of a* from 3.08 ± 1.17 to 9.80 ± 2.16 and from 10.82 ± 2.98 to 25.38 ± 3.80 for values range of b*. Baking condition can affect the colour of bread crust and bread qualities (Therdthai et al., 2002). From

Table 3, there was no significant difference ($p < 0.05$) in L* (lightness) and a* (green colour) values of crumb colour between the three sample. The values range of L* from 23.65 ± 1.78 to 27.94 ± 1.47 and from 2.27 ± 0.24 to 2.95 ± 0.21 for values range of a*. Next, there was significant difference ($p < 0.05$) in b* value (yellow colour) of crumb colour between B3 towards B1 and B2 with values range of b* from 9.26 ± 0.79 to 13.11 ± 0.51. The b* value decreased as the lightness also decreased. It might be imparted from the brown colour of whole meal flour used.

**Table 3.** Effect of processing on crust and crumb colour of whole meal breads

| Parameter | | B1 | B2 | B3 |
|---|---|---|---|---|
| Crust | | | | |
| | L* | $39.63 \pm 8.53^a$ | $36.23 \pm 2.79^a$ | $33.77 \pm 9.76^a$ |
| | a* | $9.80 \pm 2.16^b$ | $7.58 \pm 1.72^b$ | $3.08 \pm 1.17^a$ |
| | b* | $25.38 \pm 3.80^b$ | $23.31 \pm 1.75^b$ | $10.82 \pm 2.98^a$ |
| Crumb | | | | |
| | L* | $23.65 \pm 1.78^a$ | $27.73 \pm 2.98^a$ | $27.94 \pm 1.47^a$ |
| | a* | $2.27 \pm 0.24^a$ | $2.43 \pm 0.51^a$ | $2.95 \pm 0.21^a$ |
| | b* | $12.23 \pm 0.08^b$ | $13.11 \pm 0.51^b$ | $9.26 \pm 0.79^a$ |

*mean ± standard deviation
Means in the same row with different superscript are significantly different ($p < 0.05$)

**Effect of Processing on Texture of Whole Meal Bread**

Texture is one of the most important quality aspects that will affect sensory perception and shelf life of bread (Ibrahim et al., 2020). Thus, the assessment of product quality through texture analysis is an essential tool for bread products development and production. Texture of bread cause by expansion of dough during proofing and baking due to growth of gas bubbles. There was a significant difference ($p < 0.05$) between B3 bread in term of hardness, cohesiveness and chewiness towards B1 and B2 bread as shown in Table 4.

**Table 4**. Effect of processing on texture of whole meal breads

| Parameter | B1 | B2 | B3 |
|---|---|---|---|
| Hardness | $751.87 \pm 28.98^a$ | $747.16 \pm 11.43^a$ | $2425.75 \pm 75.03^b$ |
| Springiness | $1.19 \pm 0.20^a$ | $0.93 \pm 0.03^a$ | $1.28 \pm 0.21^a$ |
| Cohesiveness | $0.72 \pm 0.03^b$ | $0.75 \pm 0.11^b$ | $0.52 \pm 0.08^a$ |
| Chewiness | $495.71 \pm 130.02^a$ | $519.98 \pm 82.36^a$ | $2843.73 \pm 104.28^b$ |
| Resilience | $0.29 \pm 0.01^a$ | $0.28 \pm 0.04^a$ | $0.31 \pm 0.04^a$ |

*mean ± standard deviation
Means in the same row with different superscript are significantly different ($p < 0.05$)

The hardness of B3 bread was highest compared to other bread samples that were analysed. This was also closely related with the moisture content results as it significantly affected bread firming. When the moisture decreases, it accelerates the formation of cross links between starch and protein, thus the bread firms faster because water in bread acts as a plasticizer (He & Hoseney, 1990). Softer bread texture was perceived as fresher than firm counterparts which were generally perceived as stale (Trinh et al., 2016). Chewiness was the product of hardness, cohesiveness and springiness. Based on Table 4, there were only significant difference ($p < 0.05$) between B3 towards B1 and B2 with values range of chewiness from 495.71 ± 130.02 g to 2843.73 ± 104.28 g. Springiness was an important parameter to determine the staling and elasticity of bread as determining the extent of recovery between the first and second compression (Ibrahim et al., 2020). From Table 4 also shows that the bread sample were found no significant difference ($p < 0.05$) in term of springiness. Besides, from Table 4, there were no significant difference in springiness and resilience value for three different sample with values range of springiness from 0.93 ± 0.03 to 1.28 ± 0.21 and from 0.28 ± 0.04 to 0.31 ± 0.04 for values range of resilience.

**Effect of Processing on Pore Size of Whole Meal Bread**

Bread texture mainly can be determined through analysis the pore size. Pores was the air pockets produce in leavened bread due to fermentation that release carbon dioxide and creates a network of primarily interconnected void structures. The quality of bakery products and characterizes (structure, volume and level of digestibility) can be determined by the main indicators called porosity (Petrusha et al., 2017). Bread dough ingredients, processing conditions (kneading, fermentation, proofing and baking), yeast activity, fermentation temperature and gas bubble formation mainly effect the development of porous crumb (Rathnayake et al., 2018). Based on Fig. 1, it can be clearly seen that different processing method had affect the pore size of whole meal bread. The pore size of crumb of B2 in Fig. 1 (b) bread was bigger as compared to B1 in Fig. 1 (a) bread. Besides, the pore size of B3 in Fig. 1 (c) bread was smaller and more compact when compare to B1 in Fig.1 (a) and B2 in Fig. 1 (b) bread. Composition of bread and heating mechanism may affect the microstructure or pore size of the bread during baking (Datta et al., 2007).

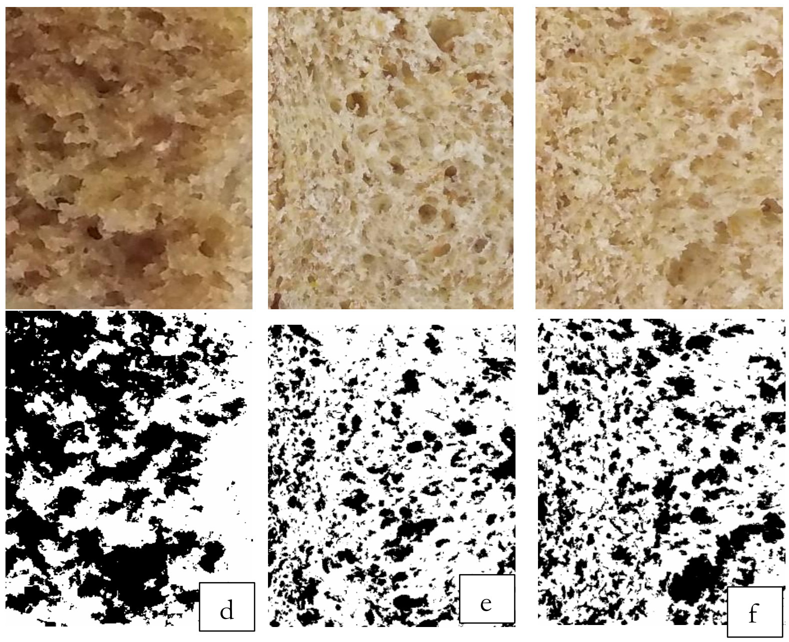


**Fig 1.** Pore size of (a) B1, (b) B2 and (c) B3 and binary image of (d) B1, (e) B2 and (f) B3 of whole meal bread by using ImageJ system

**Table 5.** Effect of processing on the total area and average size.

| Bread sample | B1 | B2 | B3 |
|---|---|---|---|
| Total Area | 3650.13 ± 182.28$^{a}$ | 3132.34 ± 272.49$^{a}$ | 3453.89 ± 339.00$^{a}$ |
| Average Size | 276.58 ± 6.48$^{a}$ | 270.35 ± 7.83$^{a}$ | 647.84 ± 15.13$^{b}$ |

a-b *indicate significant difference ($p < 0.05$)

From the Table 5, all data of total area has no significant difference ($p < 0.05$) between the three samples of whole meal bread. There was only significant difference ($p < 0.05$) between B2 towards B1 and B3 with values range of average pore size from 276.58 ± 6.48 to 647.84 ± 15.13. It can be concluded that the average pore size of B3 bread was bigger than B1 and B2 bread. Open cell was a single cell in breads which cause increased in the number of pores that reflects an increased in number of closed cells (Wang et al., 2011). Well-developed bread has porous crumb structure that contain higher gas retention capacity which cause the product volume increased and reduced crumb hardness with appealing sensorial properties (Rathnayake et al., 2018). The bigger pore size was due to processing steps of sourdough that allowed development of customized quality. Hence, B3 has least amount of porosity with bigger average size of pore. The expansion of dough due to the carbon dioxide produced by yeasts leads to the porosity that affects the texture of fermented baked dough (Boboye & Dayo-Owoyemi, 2009). Formation of voids in bread doughs cause by exhibiting of softening stress dough (Wang et al., 2011).

### Effect of Processing on Organoleptic Properties of Whole Meal Bread

Sensory evaluation by hedonic test method was used to determine the whole meal bread attributes and degree of likeness among selected panellists as aimed of this study are to determine the organoleptic properties. Based on Fig. 2, it can be concluded that the B1 whole meal bread was the most preferred among 40 panellists which the average score was higher than B2 and B3 breads. As B1 bread has good colour, porosity and moistness which was more preferred by panels among the three breads. Next, B2 still has greater preference on flavour followed by B1. Good aroma ratings indicates that the yeasts used were able to produce compounds such as alcohols, aldehydes and carbonyl which imparted appealing flavour to the bread (Boboye & Dayo-Owoyemi, 2009). According to Rathnayake et al., (2018), yeast amount and activity, fermentation and baking time and temperature affect the amount of flavour compounds formed in bread.

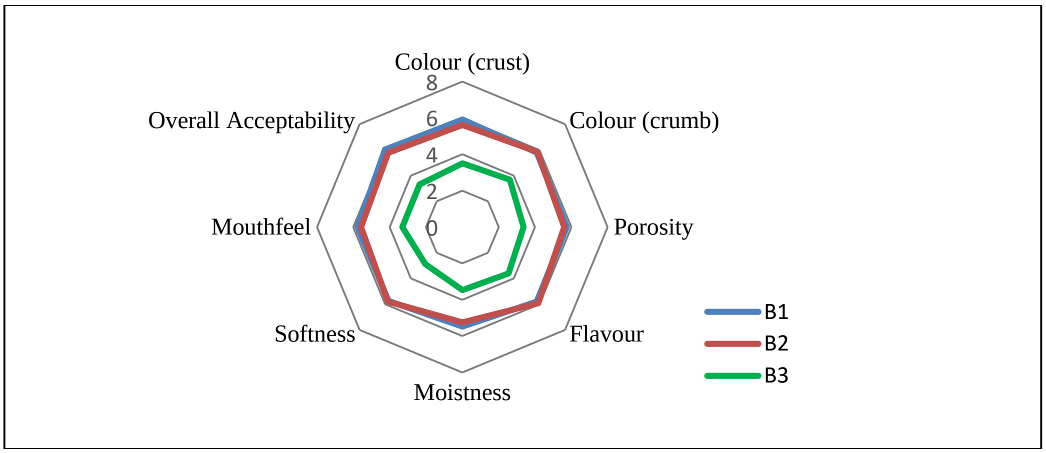


**Fig 2.** Effect of processing on organoleptic properties of whole meal breads

Sponge and dough method includes a long fermentation process to develop more intense flavour components (Cauvain, 2003). As mentioned in background of this research, straight-dough bread (B1) was chewier than bread made by other techniques as it has a coarser cell structure but also considered to have less flavour (Balestra, 2009). The score for B3 bread was the lowest among the three types of bread as most of the panels ranked all attributes of the bread as the lowest. This may due to the sourdough method that made by naturally starter culture may give unaccepted aroma, taste and texture towards panellists. In term of softness attributes, B1 and B2 bread has same average score. A softer crumb texture was generally preferred by consumers (Mann et al., 2009). It also may be caused that most of the panellists not familiar and not favourable with leaven bread that does not contained any commercial yeast. Whole meal bread consists of crumb with coarse, thick walled cell and less elastic structure (Rathnayake et al., 2018). In term of mouthfeel, panellist still can give high score for B1 and B2 whole meal bread but lower score for B3 which affect the overall acceptability.

## CONCLUSION

The differences in processing method between samples has no significant variations in physical properties such as moisture content, pore size, springiness and resilience and organoleptic properties. Straight dough (B1) and Sponge and Dough (B2) whole meal bread shows higher specific volume and lower density compare to Sourdough (B3). Hence, most panellists had given highest score of softness for B1 and B2 compared to B3. The colour of crust part of the bread samples shows that the lightness of bread decrease, which was getting darker due to the Maillard reaction occurred. Thus, the score of colours for crust and crumb higher for B1 followed by B2 and the least score was B3. Straight dough (B1) processing method of whole meal bread gave better results in physical analysis and most preferred in organoleptic analysis. In future, the obtained results would be useful for food product development by bakery food industries to produce the best quality of whole meal bread.

## ACKNOWLEDGMENTS

The first author gratefully acknowledges the science officers from Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin, Besut Campus for their technical support.

## REFERENCES

Arendt, E. K., Ryan, L. A. M., & Dal Bello, F. (2007). Impact of sourdough on the texture of bread. *Food Microbiology*, *24*(2), 165–174. https://doi.org/10.1016/j.fm.2006.07.011

Balestra, F. (2009). *Empirical and fundamental mechanical tests in the evaluation of dough and bread rheological properties* (D. S. F. Balestra (ed.)).

Behera, S. S., & Ray, R. C. (2016). Sourdough bread; In : Bread: its Fortification for Nutrition and Health (Cristina M. Russell, ed), CRC press, USA. *Bread: Its Fortification for Nutrition and Health*, *December*, 53–67.

Boboye, B., & Dayo-Owoyemi, I. (2009). Evaluation of dough sensory properties impacted by yeasts isolated from cassava. *Journal of Applied Sciences*, *9*(4), 771–776. https://doi.org/10.3923/jas.2009.771.776

Castro, W., Oblitas, J., Chuquizuta, T., & Avila-George, H. (2017). Application of image analysis to optimization of the bread-making process based on the acceptability of the crust color. *Journal of Cereal Science*, *74*, 194–199. https://doi.org/10.1016/j.jcs.2017.02.002

Cauvain, S. (2003). Bread making: Improving quality. In *Bread Making: Improving Quality*. Woodhead Publishing Limited. https://doi.org/10.1533/9781855737129

Cauvain, & Young. (2012). Water control in breadmaking. In *Breadmaking: Improving quality, Second Edition* (Second Edi). Woodhead Publishing Limited. https://doi.org/10.1533/9780857095695.2.499

Datta, A. K., Sahin, S., Sumnu, G., & Ozge Keskin, S. (2007). Porous media characterization of breads baked using novel heating modes. *Journal of Food Engineering*, *79*(1), 106–116. https://doi.org/10.1016/j.jfoodeng.2006.01.046

Decock, P., & Cappelle, S. (2005). Bread technology and sourdough technology. *Trends in Food Science and Technology*, *16*(1–3), 113–120. https://doi.org/10.1016/j.tifs.2004.04.012

He, H., & Hoseney, R. C. (1990). Changes in Bread Firmness and Moisture During Long-Term Storage. *Cereal Chemistry*, *67*(6), 603–605.

Ibrahim, U. K., Rahman, N. A. A., Suzihaque, M. U. H., Hashib, S. A., & Aziz, R. A. A. (2020). Effect of baking conditions on the physical properties of bread incorporated with green coffee beans (GCB). *IOP Conference Series: Materials Science and Engineering*, *736*(6). https://doi.org/10.1088/1757-899X/736/6/062019

Inyang, U. E. (2016). Physico-Chemical and Sensory Qualities of Functional Bread Produced from Wholemeal Wheat and Unripe Plantain Composite Flours. *MOJ Food Processing & Technology*. https://doi.org/10.15406/mojfpt.2016.02.00031

Jefferson, D. R., Lacey, A. A., & Sadd, P. A. (2007). Crust density in bread baking: Mathematical modelling and numerical solutions. *Applied Mathematical Modelling*, *31*(2), 209–225. https://doi.org/10.1016/j.apm.2005.08.017

Kunyanga, C. N., & Imungi, J. K. (2010). Quality characteristics and acceptability of bread produced with supplementation of dolichos lab lab beans. *Food Science and Technology Research*, *16*(6), 593–598. https://doi.org/10.3136/fstr.16.593

Lu, Y., Luthria, D., Fuerst, E. P., Kiszonas, A. M., Yu, L., & Morris, C. F. (2014). Effect of processing on phenolic composition of dough and bread fractions made from refined and whole wheat flour of three wheat varieties. *Journal of Agricultural and Food Chemistry*, *62*(43), 10431–10436. https://doi.org/10.1021/jf501941r

Mann, G., Diffey, S., Cullis, B., Azanza, F., Martin, D., Kelly, A., McIntyre, L., Schmidt, A., Ma, W., Nath, Z., Kutty, I., Leyne, P. E., Rampling, L., Quail, K. J., & Morell, M. K. (2009). Genetic control of wheat quality: Interactions between chromosomal regions determining protein content and composition, dough rheology, and sponge and dough baking properties. *Theoretical and Applied Genetics*, *118*(8), 1519–1537. https://doi.org/10.1007/s00122-009-1000-y

Oladunmoye, O. O., Akinoso, R., & Olapade, A. A. (2010). Evaluation of some physical-chemical properties of wheat, cassava, maize and cowpea flours for bread making. *Journal of Food Quality*, *33*(6), 693–708. https://doi.org/10.1111/j.1745-4557.2010.00351.x

Park, S. H., Chung, O. K., & Seib, P. A. (2005). Effects of varying weight ratios of large and small wheat starch granules on experimental straight-dough bread. *Cereal Chemistry*, *82*(2), 166–172. https://doi.org/10.1094/CC-82-0166

Petrusha, O., Daschynska, O., & Shulika, A. (2017). Development of the measurement method of porosity of bakery products by analysis of digital image. *Technology Audit and Production Reserves*, *2*(3(40)), 61–66. https://doi.org/10.15587/2312-8372.2018.129520

Rathnayake, H. A., Navaratne, S. B., & Navaratne, C. M. (2018). Porous Crumb Structure of Leavened Baked Products. *International Journal of Food Science*, *2018*. https://doi.org/10.1155/2018/8187318

Rosell, C. M. (2011). The Science of Doughs and Bread Quality. *Flour and Breads and Their Fortification in Health and Disease Prevention*, 3–14. https://doi.org/10.1016/B978-0-12-380886-8.10001-7

Scanlon, M. G., & Zghal, M. C. (2001). Bread structure and crumb structure. *Food Research International*, *34*, 841–864.

Therdthai, N., Zhou, W., & Adamczak, T. (2002). Optimisation of the temperature profile in bread baking. *Journal of Food Engineering*, *55*(1), 41–48. https://doi.org/10.1016/S0260-8774(01)00240-0

Trinh, L., Campbell, G. M., & Martin, P. J. (2016). Scaling down bread production for quality assessment using a breadmaker: Are results from a breadmaker representative of other breadmaking methods? *Food and Bioproducts Processing*, *100*, 54–60. https://doi.org/10.1016/j.fbp.2016.06.004

Wang, S., Austin, P., & Bell, S. (2011). It's a maze: The pore structure of bread crumbs. *Journal of Cereal Science*, *54*(2), 203–210. https://doi.org/10.1016/j.jcs.2011.05.004

Zhou, W. (2014). *Bakery Products Science and Technology Bakery Products Science* (Second Edi). John Wiley & Sons,Ltd.

**How to cite this paper:**
Abdullah, N.A. & Zulkifli, N.A. (2021). Effect of processing technique on physical and organoleptic properties of whole meal bread. Journal of Agrobiotechnology, *12*(2), 97-107.