**International Journal of Food Science and Nutrition**
**ISSN: 2455-4898**
**Impact Factor: RJIF 5.14**
**www.foodsciencejournal.com**
**Volume 2; Issue 6; November 2017; Page No. 91-94**

# Chemical composition, volume and specific volume of superheated steam and conventional oven baked bread

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**Abstract**
Effect of superheated steam baking on the quality of bread was studied. Superheated steam and conventional ovens were used for baking bread at the optimum temperature and time for both heat treatments, 180° C for 21 min using the superheated steam oven and 220° C for 20 min using conventional one. Chemical composition, volume and specific volume of bread were evaluated using the two different heating models. The moisture content and ash content of superheated steam baked bread is slightly higher than that one baked in conventional oven whereas protein content and carbohydrates of superheated steam baked bread were relatively low compared to the conventional baked one. Both of the heat treatments bread gave the same fat content value. Superheated steam baking gave slightly higher bread volume compared to that one obtained using conventional baking. (316 and 307 $cm^3$ respectively). The two bread samples were almost gave the same specific volume values.

**Keywords:** bread, superheated steam oven, conventional oven, proximate composition, volume, specific volume

## 1. Introduction
Superheated steam is a type of unsaturated steam generated by additional sensible heat to saturated or wet steam. The additional heat causes increasing of steam temperature above the saturation or boiling point at a given pressure. Superheated steam is using for drying products, it causes changes such as starch gelatinization, enzyme destruction, protein denaturation, color and texture changes and deodorization (Devahastin, Suvarnakuta, Soponronnarit, & Mujumdar, 2004) [6], (Tang & Cenkowski, 2000) [19], and (Tang & Cenkowski, 2000, 2001) [19, 20]. Superheated steam in food processing not only used for drying but it is preferred for heat treatment of food products. Advantages of superheated steam oven over conventional oven including air free environment, enhanced product quality, improved energy efficiency, higher drying rate, and reduced the impact of the environment when condensate is reused (Prachayawarakorn, Prachayawasin, & Soponronnarit, 2004, 2006; Prachayawarakorn, Soponronnarit, Wetchacama, & Chinnabun, 2004) [13, 15, 14]. Superheated steam helps in preventing oil oxidation whilst preserving nutritional components in food products (Sotome & Isobe, 2011) [16]. Food products have a better aroma when they dried with superheat steam. Furthermore, some valuable volatile organic compounds could be recovered and separated by the condenser (Karimi, 2010) [9]. Superheated steam has been applied to various kinds of food processing such as blanching, pasteurization, extraction, sterilization, and deodorization of the products (Van Deventer & Heijmans, 2001) [21]. Recently, it has been used for drying many kinds of food products such as potatoes (Caixeta, Moreira, & Castell-Perez, 2002), grains (Tang & Cenkowski, 2001) [20] and soya bean (Prachayawarakorn *et al.*, 2006) [13, 15].
Bread volume is one of the most apparent interactions of dough during the baking process, The final bread quality including bread volume and specific volume and other parameters is affected with many factors such baking temperature and time and addition of fibers. The addition of too much fiber produces bread of poor quality in terms of texture, loaf volume, and appearance (Gómez *et al.* 2003; Wang *et al.* 2002) [7, 23].
Bread has had great role as one of the most staple food in the diet consumed by humans. It is one of the oldest processed food. Bread is a leavened product which can be made by the fermentation process of cereal flour sugars by the yeast and natural enzymes of flour (Mondal and Datta 2008) [12]. Bread plays a major role and considered as a vehicle for the nutritional improvement of the man diet. Even today around the world bread is one of two principle foods providing nutrients to man. Over 50% of the countries in the world receive more than one-half of their total caloric intakes from bread (Barrett, 1975) [4].
Some heating methods were studied as alternative to conventional heating including infrared and hot air assisted microwave heating (Datta & Ni, 2002) [5], microwave-hot air combination heating (Lu, Tang, & Liang, 1998) [11], microwave-impingement combination heating (Walker *et al.*, 1993) [22] and halogen lamp-microwave (Keskin, Sumnu, & Sahin, 2004) [10]. Using superheated steam for baking process is not introduced yet, thus the aim of the present work was to study the effect of superheated steam baking on the bread quality including chemical composition, volume and specific volume.

## 2. Materials and Methods
### 2.1 Materials
Wheat flour, salt and dry yeast were obtained from the market in Penang, Malaysia. The chemicals of analytical grade were obtained from School of Industrial Technology, Universiti

Sains Malaysia, Malaysia.

### 2.2 Methods

#### 2.2.1 Bread Preparation and Baking Test

Straight dough method was used for preparing the bread dough according to Badi and colleagues (Badi *et al.*, 1978) [2] with some modification, using the following formula:

Flour=250gms, Dry yeast=2.5gms, Salt=2.5gms, Ascorbic acid=8O ppm and water =165 ml. All ingredients were mixed by a mixer (Spar Food Machinery MFG model 800 - C) for 5 minutes then the dough was placed into incubator (Broofer Bakbar E81) at 30° C and medium relative humidity for fermentation. After 20 min the dough was taken out of the incubator, punched, divided into rounded dough balls and placed into the incubator again for another 20 min under the same condition. The dough was divided into 120 g pieces after fermentation. Each piece was shaped and placed in baking tin into the incubator for the final proof for 15 min under the same incubation condition for fermentation. The baking was performed using superheated steam oven (Healsio, AV-1500V, SHARP) in superheated steam model and conventional model (normal without steam). Preheat was carried out to reach the specific oven temperature then, the fermented dough samples were baked at the optimum temperature and time for both heat treatments 180° C for 21 min using the superheated steam oven and 220° C for 20 min using conventional one. Three loaves of breads were baked at the optimum temperature.

#### 2.2.2 Proximate composition

Moisture content, total fat, ash and crude fiber were determined according to the Association of Official Analytical Chemistry Method (Association of Official Analytical Chemistry 2000). Nitrogen content was determined by the Micro-Kjeldahl technique following AOAC. Nitrogen was converted to protein by using factor of 6.25. The total carbohydrates were calculated by difference.

#### 2.2.3 Evaluation of bread quality

The different types of bread were cooled at room temperature for an hour after baking and quality measures were made in triplicate loaves as follows:

**a) Bread volume**

The loaf volume expressed in cubic centimeters was determined by seed displacement in a loaf volume meter. The loaf was placed in a container of known volume into which small seeds (millet seeds) were run until the container was full. The volume of seeds displaced by the loaf was then directly indicated.

**b) Bread weight**

The loaf weight of the bread was taken in gram.

**c) Bread specific volume**

The loaf specific volume was calculated by dividing the volume/weight (cc/g).

### 2.3 Statistical analysis

All bread samples for each heat treatment parameter were performed in triplicate. Data that obtained was expressed as means of measurements. The experimental data were analyzed using SPSS 24.0, by compare means, the significance difference was considered at the level of $p < 0.05$ using t-test.

## 3. Result and discussion

### 3.1 Proximate composition

The proximate composition of conventional and superheated steam baked bread is presented in figure 1. The moisture content of superheated steam baked bread was relatively higher than that one baked in conventional oven as can be seen in the mentioned figure. The obtained moisture content of bread baked in both heating models was less than that one (35.3-36.5%) which was obtained by Barcenans and Rosell (2006) [3].

Generally, the variation in moisture content is attributed to the variation in bread components and both temperature and time of baking as well as heating model that used for baking process. Both superheated steam and conventional baked bread gave the same value of fat content (0.18 %) as can be observed in the figure. Superheated steam baked bread showed the highest value of crude fiber content. Ash content of superheated steam baked bread is slightly high compared to the conventional baked one.

It could be observed from this figure that the value of crude protein content of superheated steam baked bread was slightly low compared to the conventional baked one. Superheated steam baked bread gave the lowest result of total carbohydrates compared with the conventional baked bread.

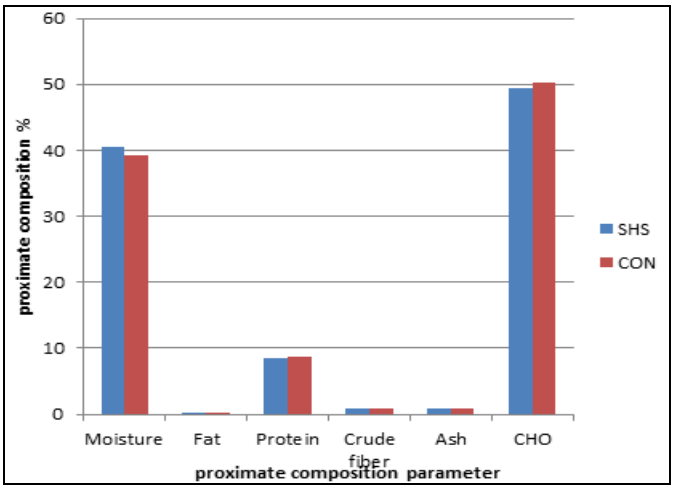


**Fig 1:** proximate composition of conventional and superheated steam baked bread

### 3.2 Bread quality

**Bread volume, weight and specific volume**

The volume of bread baked using superheated steam baking was a little bit higher compared to that one obtained using conventional baking. (Table 1).

Bread specific volume of superheated steam and conventional baked ones was shown in table (1). Two bread samples were almost gave the same specific volume values as can been seen in the mentioned table. He and Hoseneney, (1992) stated that the specific volume of bread reach the maximum during baking process. Bread making is divided into three stages including dough making then fermentation and the baking at the end (Pomeranz and Shellenberger, 1971) [18]. Sufficient baking temperature and time are important factors for starch-gluten matrix reactions (Pomeranz and Shellenberger, 1971) [18]. Keskin and colleagues, (2004) [10] observed that using halogen lamp heating and halogen lamb microwave combination heating in baking focusing the radiation at the surface of bread forming sudden thick crust at the surface of bread causing reduction of heat transfer to the inner part and hence less bread expansion (Keskin *et al.*, 2004) [10]. High levels of fiber dilute gluten lowers gas retention thus causing a decrease in loaf volume. Sosulski and Wu (1988) [17] explained that bread fortified with pea hulls decreases loaf volume, increases water absorption, and decreases the overall bread quality sequentially with increases in the substitution level.
Bread volume is affected with many factors including addition of too much fiber, dough fermentation, baking temperature and time as well as heating model used for baking process.

**Table 1:** volume, weight and specific volume of superheated steam and conventional baked bread

| Bread Source** | Loaf Weight (g) | Loaf volume ($cm^3$) | Specific volume ($cm^3/g$) |
|---|---|---|---|
| SHS | 107.23 | 316 | 2.95 |
| CON | 105.18 | 307 | 2.92 |

* Statistically significant at $p<0.05$
**SHS=superheated baked bread, CON= conventional oven baked bread

## 4. Conclusion
Superheated steam and conventional ovens were used for baking bread at the optimum temperature and time, 180° C for 21 min for superheated steam oven and 220° C for 20 min for conventional oven. Proximate composition, volume and specific volume of bread were evaluated using the two different heating models. Superheated steam baked bread gave slightly higher moisture and ash content than the conventional baked one, whereas relatively low protein content and carbohydrates compared to the conventional baked one. Both of the heat treatments bread gave the same fat content value. Superheated steam baking gave slightly higher bread volume compared to that one obtained using conventional baking while almost the same specific volume value was obtained for both heating models.

## 5. Acknowledgement
Acknowledgement and Special thanks to USM fellowship scheme of Institute of Postgraduate Studies, Universiti Sains Malaysia for funding this study.

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