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# The Alteration of Physicochemical and Thermal Characteristics of Peanut by Salting-Roasting Process

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**Abstract.** Peanut as nutritious food containing high protein, high fat, carbohydrate, and bioactive substance is usually processed in order to enhance palatability and consumer preference. One of the thermal processes, a traditional salting-roasting process used by BIMARAM SME in Gunungkidul to add the value of peanut, was predicted to be able to alter the properties of peanut, i.e., physicochemical and thermal characteristics. This research investigated the alteration, and the comparison of salted-roasted peanut and raw peanut properties was essentially needed to be conducted. Physicochemical characteristics were represented by parameters such as moisture content, ash content, fat content, protein content, antioxidant activity, color, mean geometric peanut kernel diameter, kernel size distribution, hardness, and fracture parameter. Meanwhile, thermogravimetric analysis (TGA) result described thermal characteristic. The salting-roasting process produced the decreasing of moisture, protein, fat, antioxidant activity expressed by antiradical power, and CIE Lab color values (lightness ( $L^*$ ), redness ( $a^*$ ), and yellowness ( $b^*$ )), compared with that of raw peanut. Meanwhile, the ash content of the peanut was increased by the process. All of the changes were significant ( $p < 0.05$ ) statistically. The process reduced the mean geometric peanut kernel diameter ( $p < 0.05$ ) and yielded a narrower kernel size distribution. According to TGA result, the roasted peanut was more stable thermally, which was shown by the shifting of endothermic peak to the higher temperature. The enhancing of palatability of peanut by salting-roasting was proven by hardness decreasing ( $p < 0.05$ ), although the fracture was insignificantly increased ( $p > 0.05$ ).

## 1. Introduction

Peanut or groundnut classified as *Arachis hypogaea* was dominantly produced by Asia's countries. China and India respectively occupy the first and second of overall world peanut production [1]. Indonesia with other southeast countries like Myanmar and Vietnam also produce peanut substantially [2]. Even, fifth-ranking position of world peanut production is occupied by Indonesia [3]. Indonesia's productivity of peanut is in the sixth position after cassava, sweet potato, paddy, maize, and soybean and the area of peanut production was dominated by Jawa Island's province [4]. DI Yogyakarta province is third peanut crops area which the contribution to national crops total is 12.46%. Based on BPS-Statistics of D.I. Yogyakarta Province 2018, Gunungkidul regency leads in harvester area of peanut which the contribution is 90.44% [5].



According to USDA National Nutrient database, peanut is nutritious food that contains protein (25.80%), fat (49.24%), fiber (8.5%), vitamin, mineral [1]. It also consists of bioactive components like arginine, resveratrol, phytosterol, phenolic acid, and flavonoid that involve with coronary heart disease risk decreasing and chemopreventive activity [6]. Peanut can be served and consumed in raw or processed form such as boiled, roasted, fried peanut and also other added value products such as peanut butter and peanut candy [7]. Peanut processing, one of them is roasting, is needed to enhance palatability and consumer preference including color, flavor, and texture attribute. Roasting was also aimed to destroy microorganism, food contaminant, and other toxins [8]. However, thermal processing including roasting can alter the properties of peanut because of its high heat penetration [9].

Besides roasting, salting process is used for taste and flavor food enhancing. The process plays a role in food properties changes because mass transfer occurs by the process. Water is released out through semi-permeable food membrane because of the osmotic pressure gradient. Meanwhile, the salt substance can be lost from water, penetrate, and enter into food matrix through the membrane. This salt entering will influence the taste and other food properties [10].

BIMARAM as one Small Medium Enterprise (SME) in Gunungkidul regency produces various peanut-based food, one of them is traditional salted-roasted peanut snack. The snack consumption can fulfill daily nutrient adequacy. However, the peanut processing firmly involved with thermal processing can alter the physicochemical and thermal characteristics properties including the nutrient. By this research, the physicochemical and thermal characteristics of salted-roasted peanut were investigated. Moisture content, ash content, fat content, protein content, and also antioxidant activity, color, hardness, fracture, peanut size, and peanut size distribution were the parameters which describe physicochemical properties. Meanwhile, the thermal properties were represented by a thermogravimetric property. Regarding with macronutrient (recommended dietary allowance) fulfillment, it is imperative to consider moisture, fat, protein content of processed peanut. The ash content interpreting mineral along antioxidant activity had to be studied because they refer to human body micronutrient. Meanwhile, the hardness, fracture, peanut size and size distribution are involved with sensory palatability and visual preference [3]. The effect of roasting on peanut had been studied by many researchers. However, the simultaneous salting-roasting have not been enormously investigated yet. The properties of salted-roasted and raw peanut are needed to be compared and discussed for investigating how far the salting-roasting process can alter the peanut properties.

## **2. Material and methods**

### *2.1. Material*

Raw peanut seed used by BIMARAM SME was obtained from Rongkop district harvesting. The raw peanut had been dried traditionally by sun drying, and the peanut kernel had been separated from the shell. For peanut properties analysis, some chemical was used. Petroleum ether,  $\text{H}_2\text{SO}_4$ ,  $\text{Na}_2\text{SO}_4$ ,  $\text{HgO}$ ,  $\text{NaOH}$ ,  $\text{Na}_2\text{S}_2\text{O}_3$ ,  $\text{HCl}$  37%, and  $\text{HBO}_3$  were obtained from Merck (USA). 1,1-Diphenyl-2-picrylhydrazyl (DPPH) was obtained from Sigma-Aldrich (USA). Ethanol was purchased from Merck (USA).

### *2.2. Methods*

*2.2.1. Salted-roasted peanut preparation.* Salted-roasted peanut was prepared by BIMARAM SME. Briefly, the raw peanut was soaked with boiling water for a moment, afterward, the peanut was cleaned by tap water. The seasoning dominated by salt was given to cleaned peanut so that the step can be mentioned as salting. The salting peanut was dried under sunlight until its moisture was reduced. Dry roasting was traditionally conducted by using a white sand medium. The roasted peanut was packaged with an air-tight plastic bag until it would be analyzed.

*2.2.2. Physicochemical properties analysis.* The physicochemical properties were represented by moisture content, ash content, fat content, protein content, antioxidant activity, color, mean geometric peanut kernel diameter, kernel size distribution, hardness, and fracture. The proximate (chemical compositions) of peanut consisting of moisture, protein, fat, and ash content were determined by

reference based on the Association of Official Analytical (AOAC, 1995) [11]. Sample preparation before analysis was conducted by grinding peanut kernel with mortar and pestle by a method of Abdulsalami and Sheriff, 2010 [12]. Crude protein was determined by using the micro-Kjeldahl method (AOAC, 928.08). Soxhlet extraction with petroleum ether was used for determining crude fat (AOAC, 920.39c). Moisture content was analyzed by thermogravimetric method (AOAC, 950.46). The thermogravimetric method was also used for determining crude ash (AOAC, 923.03).

The antioxidant activity expressed by antiradical power (ARP) was determined by DPPH antiradical procedure [13]. However, the procedure was modified for microplate method. Before DPPH antiradical analysis, fine powder peanut defatted by using petroleum ether was extracted by ethanol 80% at room temperature for overnight. The suspension was centrifuged to get clear supernatant. The supernatant was hereinafter mentioned as a sample solution. The dilution of the sample solution and DPPH was carried out by using ethanol 80% for creating them into various concentration. The principal of DPPH antiradical method is the reaction between sample solution containing antiradical activity and purple-colored radical DPPH solution to form yellow-colored non-radical (reduced-radical) solution. For the initial step, DPPH calibration curve was essentially made by plotting some concentration DPPH (0-100  $\mu$ M) versus their absorbance. The standard curve could be utilized for looking for the DPPH concentration for both initial and remaining DPPH concentration which the terms will be further explained. Afterward, about 100  $\mu$ l sample solution and its diluted solution with various concentration were poured to 96-well microplate. Then, about 100  $\mu$ l DPPH solution 75  $\mu$ M was added to wells containing sample solution. The mixing was called a DPPH-sample mixed solution. The mixing of 100  $\mu$ l DPPH solution 75  $\mu$ M and 100  $\mu$ l ethanol 80% was made as control depicting unreacted DPPH solution by any antiradical sample solution, and that was called as a control solution. The blank sample solution had to be made for correcting sample color (if sample color could not be ignored) by mixing of 100  $\mu$ l sample solution and 100  $\mu$ l ethanol 80%. Meanwhile, the blank solution used in this analysis was 200  $\mu$ l ethanol 80%. After the pouring to microplate was finished, the microplate was shaken in Elisa reader for 10 seconds (Thermo Scientific Multiskan GO Type 1510, Thermo Fisher Scientific, Finland) and the absorbance was measured at 515 nm by using the reader. The absorbance of control solution of this step was utilized to look for initial DPPH concentration by referring absorbance value to the standard DPPH curve. Meanwhile, the step was resumed by incubating microplate for 30 minutes at the dark condition to allow the reaction of DPPH and antiradical sample. The absorbance was measured at the same wavelength. The further step was the finding of initial and remaining DPPH concentration for calculating remaining DPPH percentage according to the following equation:

$$\% \text{ remaining DPPH} = \frac{[\text{remaining DPPH}]}{[\text{initial DPPH}]} \times 100\%$$

The initial DPPH determination was conducted by subtracting blank solution absorbance from control solution absorbance. On the other hand, remaining DPPH concentration was obtained by subtracting blank sample solution absorbance from DPPH-sample mixed solution absorbance. The plot of sample solution concentration versus remaining DPPH percentage was used to determine the half maximal effective concentration (EC50) figuring sample concentration that causes a 50% DPPH decrease. For clarity, another term used for expressing antioxidant activity is antiradical power (ARP = 1/EC50), in which higher ARP value represents higher antioxidant activity [14].

The measurement of peanut seed diameter was adopted from Kurt and Arioglu, 2018 [15]. The peanut kernel diameter was measured by using digital caliper with the accuracy of 0.01 mm. Principal dimension on peanut size measurement was described as following: major axis was expressed as Length (L), the intermediate axis was expressed as Width (W), the minor axis was expressed as Thickness (T). The geometric diameter ( $D_e$ ) was determined according to the following equations developed by Polat et al., 2007 [16]:

$$D_e = (LWT)^{\frac{1}{3}}$$

Texture profile analysis was performed by using TA1 texture analyzer (Llyod Instruments) with 10 mm/s test speed and 1N preload/stress. Hardness and fracture were chosen as texture attributes because they represented palatability parameters of peanut.

Peanut color was identified colorimetry by chromameter (Konica Minolta CR-80) according to Priatková method [17]. The color is expressed as CIE L\*a\*b\*. Value of L\* indicates lightness with 0 refers to dark, and 100 refers to white, redness/greenness was indicated by a\* value, in which positive (+) value refers to redness and negative (-) value refers to greenness. Meanwhile, b\* indicates yellowness/blueness in which yellowness and blueness are interpreted from positive (+) and negative (-) value respectively.

**2.2.3. Thermogravimetry analysis.** The thermal profile of peanut was obtained by using thermogravimetric analysis (TGA) analyzer (DTG-60 Shimadzu) in which the heating temperature was of 10°C/min and the nitrogen was used as purging gas with the flow rate 30 ml/min. The sample was heated at a temperature range of 30-300 °C.

**2.2.4. Statistical analysis.** Collected data were statistically analyzed by SPSS 12. The independent sample t-test was used for obtaining significance of the difference among means of raw and salted-roasted peanut. Confidence interval used in this analysis was 95%.

### 3. Results and discussion

#### 3.1. Physicochemical properties

A salting-roasting process involving with salt (sodium mainly) adding and heat treatment affect the proximate properties and antioxidant activity of peanut, it can be seen in Table 1. The table shows that salting and roasting caused decreasing in moisture, protein content, and also anti-radical power of peanut. However, ash content increased by the salting-roasting process.

**Table 1.** The proximate properties and antioxidant activity of raw and salted-roasted peanut.

Parameters	Raw peanut	Salted-roasted peanut
Moisture (% WMB)	8.68 ± 0.06 <sup>a</sup>	4.31 ± 0.28 <sup>b</sup>
Ash content(% DMB)	2.17 ± 0.17 <sup>a</sup>	3.87 ± 0.07 <sup>b</sup>
Protein content (% DMB)	31.83 ± 0.46 <sup>a</sup>	30.66 ± 0.51 <sup>b</sup>
Fat content (% DMB)	49.55 ± 0.06 <sup>a</sup>	45.21 ± 1.64 <sup>b</sup>
Antiradical Power (mg DPPH/mg dried peanut)	1.06 ± 0.13 <sup>a</sup>	0.44 ± 0.06 <sup>b</sup>

Same superscript letters at same row indicate insignificant differences

<sup>1</sup> WMB = wet mass basis

<sup>2</sup> DMB = dry mass basis

Moisture of raw peanut was higher than that of salted-roasted peanut. It is clear that high temperature (exactly more than 100°C) produced by roasting can cause dehydration (water releasing). Water was released from the food system by vaporization. In addition, at the high-temperature roasting process, dehydration is not only involved with free water but also bound water which will be released by roasting. The higher the roasting temperature, the more water can be released. Salt (mainly sodium and chloride) substances applied for peanut salting can also induce water-out of food matrix through osmotic dehydration process [10]. The result is useful for food preservation because the microorganism usually lives in a moist environment.

The salting-roasting process improved the ash content of peanut because of mineral substances mass transfer. Mineral substances composing salt (sodium and chloride) can enter into peanut matrix. Moreover, the media used for dry roasting was sand obtained Gunungkidul's beach, in which calcium, magnesium, and other mineral substances compose the sand [18]. It is predicted that there was mass transfer the substance to the food matrix.

The decrease in protein and fat mainly was induced by high thermal roasting. Our finding agreed with an investigation about peanut soluble protein decreased by air-oven roasting [19]. Non-enzymatic protein-carbohydrate reaction and denaturation of protein strengthened by high temperature were involved in the phenomenon [20]. Especially in this research, the protein was also reduced by treatment before the roasting process (peanut soaking with boiling water). Although the process took place for a moment, it allowed the soluble protein to be released from the food matrix. Meanwhile, the declining peanut fat by roasting suited the oven-air roasting of peanut conducted by Makeri et al., 2011 [21]. The roasting process disrupts peanut tissue so the fat (oil) can be liberated from it [9]. If roasting temperature reaches certain peak, the fat (oil) can permeate towards at surface and will be separated from food system [21].

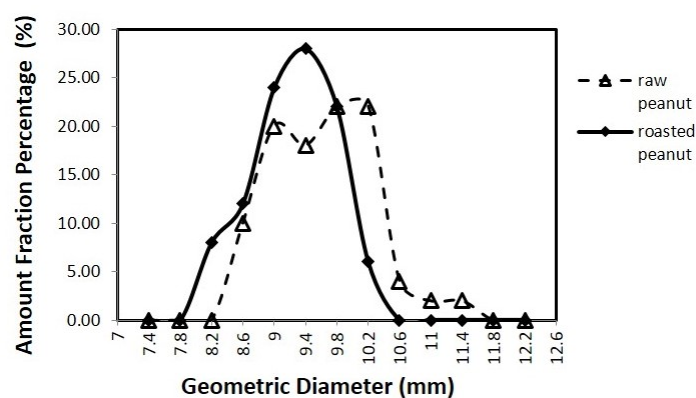
Regarding peanut antioxidant activity, the antiradical power of roasted peanut was less than that of raw peanut. Phytochemicals, such as polyphenol and flavonoid, contributing peanut antioxidant activity are concentrated in peanut skin [22]. Phytochemical can be degraded easily by many external factors and the skin is the early part of peanut exposed by heat processing, so the finding that raw peanut had more efficient antioxidant activity is proper.

Salting-roasting influenced the kernel peanut geometry by reducing diameter. The difference between roasted-peanut diameter and raw peanut diameter was significant ( $p < 0.05$ ). It can be seen from Table 2.

**Table 2.** Mean geometric diameter of raw and salted-roasted peanut.

Parameters	Raw peanut	Salted-roasted peanut
Mean geometric diameter	$9.62 \pm 0.65^a$	$9.24 \pm 0.53^b$

Same superscript letters at same row indicate insignificant differences



**Figure 1.** Peanut kernel size distribution

According to Figure 1, salting-roasting brought the kernel size distribution to be narrower than the raw peanut. It might be caused by simultaneous moisture, fat, and protein component lost. The phenomenon may be a trigger in structure modification; furthermore, it can affect geometric properties. The differences among means of raw peanut and salted-roasted peanut were significant ( $p < 0.05$ ). This implies that the influence of salting-roasting process has to be considered in peanut-based nutrient adequacy.

According to color data of Table 3, salting-roasting influenced significantly for all color properties. Lower  $L^*$  value of salted-roasted peanut indicated that it was darker than the raw peanut. The darkness of roasted peanut resulted from a non-enzymatic browning reaction. The lowering  $a^*$  and  $b^*$  value of salted-roasted peanut indicated phytochemical degradation. The value of  $a^*$  and  $b^*$  of peanut contribute to polyphenol and proanthocyanidin respectively [22].

**Table 3.** Color properties of raw and salted-roasted peanut.

Parameters	Raw peanut	Salted-roasted peanut
L*	46.93 ± 0.12 <sup>a</sup>	46.60 ± 0.86 <sup>b</sup>
a*	11.83 ± 0.74 <sup>a</sup>	7.43 ± 0.47 <sup>b</sup>
b*	14.63 ± 0.42 <sup>a</sup>	12.87 ± 0.59 <sup>b</sup>

Same superscript letters at same row indicate insignificant differences

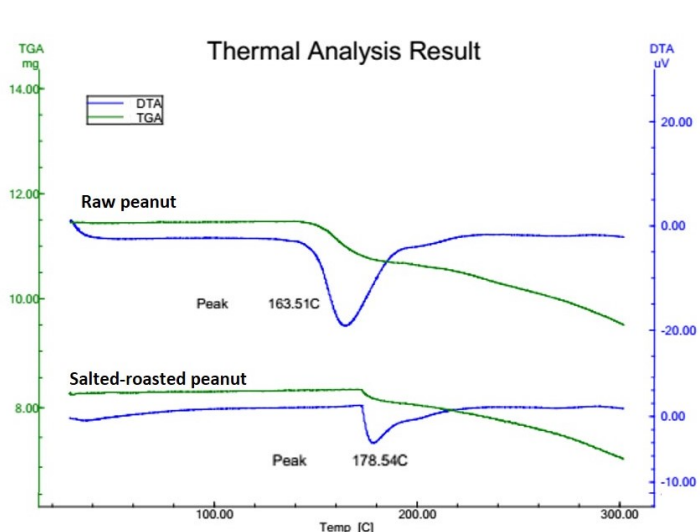
Salting-roasting could change textural properties of peanut by decreasing hardness of raw peanut ( $p < 0.05$ ), although the fracture value of salted-roasted peanut was higher. Fortunately, the fracture difference was not significant ( $p > 0.05$ ). This result gave an advantage because the harder snack is usually avoided by the consumer.

**Table 4.** Textural properties of raw and salted-roasted peanut.

Parameters	Raw peanut	Salted-roasted peanut
Hardness (N)	71.57 ± 7.11 <sup>a</sup>	20.97 ± 2.31 <sup>b</sup>
Fracture (N)	8.73 ± 2.96 <sup>a</sup>	9.58 ± 2.10 <sup>a</sup>

Same superscript letters at same row indicate insignificant differences

### 3.2. Thermal Properties

**Figure 2.** Thermal analysis result of raw and salted-roasted peanut.

Thermogravimetric analysis (TGA) profile of both raw peanut and salted-roasted peanut was depicted in Figure 2. The endothermic peak of both raw and roasted peanut from 100-200 °C indicated dehydration. It can be seen that the roasting process shifted the endothermic peak of peanut (properly 163.51) to the higher temperature (178.54°C). The roasting process can modify food structure so that it can influence the releasing of water (both free and bound water) from the food matrix.

### 4. Conclusions

Salting-roasting process alters the physicochemical and thermal characteristics of the peanut. Roasting especially brought peanut to be more stable thermally, because the free water vaporization was accomplished by roasting. The salting-roasting also made geometrically, and texture properties of peanut met palatability and visual consumer preference by improving size distribution and reducing the hardness. Generally, physicochemical properties (moisture, protein, fat, and antiradical power) was

decreased by roasting. Even though, increasing in ash content happened. It was involved with osmotic dehydration and mineral mass transfer during salting, and also high temperature treating to the peanut during the roasting process. Moisture decline by the roasting process is useful because it aids food preservation. However, regarding with macronutrient (protein, ash, fat) and antiradical power uptake for the human body, the research is needed to be reinvestigated to search available traditional salting-roasting condition, including roasting temperature or time factor by using more standard roasting equipment.

## 5. Acknowledgments

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