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Physical characteristics and sensory evaluation of cookies prepared from wheat flour and immature Manis Terengganu melon flour blends

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This study examined the effects of immature Manis Terengganu melon flour substitutions at various proportions and evaluated its physical behavior. Four types of formulations of cookies were prepared with immature Manis Terengganu melon flour ranging from 0% (MTF0), 5% (MTF5), 10% (MTF10), and 15% (MTF15) in which MTF0 serves as control cookie. Physical properties (weight loss, diameter, thickness, spread ratio, color, and hardness) and sensory attributes of the cookies were evaluated. The weight loss was found to be higher in MTF0 (36.35%), meanwhile, the weight-loss showed an increasing trend as the percentage increased from 19.41% (MTF5) to 24.97% (MTF15). The color analysis differed significantly between samples. The L* value decreased from 70.42 (MTF0) to 60.58 (MTF15). Whereas for b* value, a decrease from 37.53 (MTF0) to 34.76 (MTF15) was observed. The hardness of cookies decreased with the increment of immature Manis Terengganu melon flour. Cookies made from 15% immature Manis Terengganu flour are easy to break into two (Hardness= 1.50 kg) compared to 0% (Hardness= 2.97 kg). Sensory data indicated that the addition of immature Manis Terengganu flour in the cookies resulted in a decrease in mean score for overall acceptability. The increasing percentage of immature Manis Terengganu flour substitution to the wheat flour affected the physical properties and acceptability of the cookies.

Keywords: Manis Terengganu Melon, flour blend, cookies, physical characteristics, sensory evaluation

INTRODUCTION

Rockmelon (*Cucumis melo*) belongs to the Cucurbitaceae family. It possesses numerous nutritive and medicinal functions due to the rich sources of biologically active constituents (Qian et al. 2019). Manis Terengganu melon is the first variety of rockmelon family which only cultivated mainly in Terengganu, Malaysia. It has unique characteristics such as yellow smooth outer skin, 'color-like-salmon' fleshed, and has moderate sweet (Brix°13) at full maturity and grown using fertigation method. The quality of the fruit only lasts about two weeks after harvesting even when harvested, handled, and held in optimum condition (Muhamad and Basri, 2019).

Due to high demand, a good production practice was applied to produce excellent quality fruits. Farmers practically remove immature fruits from trees at day 30 – 40, leaving only one fruit for each tree to provide selected fruit adequate nutrients for harvesting and marketing. Thus, increasing the production of Manis Terengganu melon fruits will also increase the waste (immature fruits) and consequently threaten the environment (Qian et al. 2019). This study focused on the immature fruits that have been removed from the plants.

To our best knowledge, there is no published work on the immature Manis Terengganu melon fruits to become shelf-stable foods. Cookies are shelf-stable baked product that been characterized by low water content. Their three major ingredients are typically flour, sugar and fat and other ingredients such as syrups, salt, and emulsifiers. The differences between the distinct types of cookies are depending on cookie composition, cookie dough making, cookie formulation and baking parameters (Mancebo et al. 2015). According to Pareyt and Delcour (2008), they stated that flour is the main ingredient in cookie dough formulas and consists mainly of starch, water, and protein. Therefore, this study was carried out to determine the physical characteristics and sensory evaluation of the cookies produced from a different percentage of immature Manis Terengganu melon flour and determine the overall acceptability of the cookies made from wheat flour and immature Manis Terengganu flour (MTF) mix.

MATERIALS AND METHODS

A sampling of immature Manis Terengganu melon and other materials

Immature Manis Terengganu melons were collected from Ladang Tanaman Manis Terengganu, Alur Lintang, Besut. The immature fruits were carefully chosen by measuring similar Brix (Brix° 4.5-5), the average diameter (6-8 cm), length (8-10 cm), and weight (150 – 200 g). The fruits were chilled at 4 °C to maintain their physical and chemical properties. The other ingredients such as wheat flour, eggs, butter, castor sugar, milk powder, vanilla essence, baking powder, and salt were purchased from the bakery shop and supermarket at Bandar Jerteh, Terengganu.

Preparation of immature Manis Terengganu flour

Immature MTF was prepared as described by Muhamad and Mohd Redzuan (2019) with slight modifications. The immature Manis Terengganu melons were washed under running tap water to eliminate dirt and other unwanted materials. Any immature Manis Terengganu melon that shows the appearance of bruises and holes was removed. The immature Manis Terengganu melon skins were peeled manually using a knife and sliced using a slicer machine (Sirman, Smart 250, UK) at a thickness of 5 mm. After that, the melon slices were immersed in 0.2% sodium metabisulphite for 15 minutes to avoid the browning reaction. Then, the melon slices were dried in a cabinet dryer at 50 °C until constant weights were obtained. The dried Manis Terengganu melon slices were ground into powder by using blender equipment (Panasonic, 300W Blender, Malaysia). Lastly, the powder was passed through sieved using 250 µm mesh sieve to get uniform flour size. The flour was stored in an airtight container at room temperature.

Composite flour preparation

Four composite flours were prepared by substituting immature MTF to wheat flour in the percentage proportion of 0:100, 5:95, 10:90, and 15:85% respectively. It is recommended that up to 15% flour substitution could be adopted in baking making processes (Ezeocha et al. 2016). MTF0 represents cookies produced from 100% wheat flour, MTF5 represents cookies produced from 95% wheat flour, and 5% immature MTF, MTF10 represents cookies produced from 90% wheat flour and 10% immature MTF and MTF15 represents cookies produced from 85% wheat flour and 15% immature MTF.

Preparation of cookies

Cookies were prepared as described by Ho and Abdul Latif (2016) with slight modifications. The formulations used are presented in Table 1.

Table 1: Formulation of cookies from MTF and wheat flour

Ingredients (g)	MTF0	MTF5	MTF10	MTF15
Wheat flour	180	171	162	153
MTF	0	9	18	27
Castor sugar	60	60	60	60
Butter	100	100	100	100
Egg (unit)	1	1	1	1
Milk powder	6	6	6	6
Baking powder	3.5	3.5	3.5	3.5
Salt	1	1	1	1
Vanilla essence (mL)	2	2	2	2

MTF has replaced the wheat flour with 0, 5, 10, and 15% for the preparation of MTF0, MTF5, MTF10, and MTF15 respectively. The cookies that have been formulated without any MTF was used as the control (MTF0). The dry ingredients were weighed using an analytical balance and thoroughly mixed in a bowl. The butter and sugar were mixed until fluffy. Then, an egg and other dry ingredients (MTF and wheat flour, milk powder, baking powder, salt) were added. The dough was kneaded for 4 min and rolled manually by using a rolling pin to the thickness of 5 mm. The sheeted dough was cut with a 28 mm diameter round shape cookie cutter. All shaped dough was placed on a greased tray and baked for 14 min at 180 °C in an oven. After baking, the cookies were cooled for 30 min at room temperature before it was packed in an airtight plastic container prior to analyses.

Determination of Physical Analysis of the Cookies

Weight loss

The cookies were selected randomly for weight loss measurement. The weight loss of cookies was calculated by weighing five cookies before and after baking. The difference in weight was averaged and reported as percent weight loss.

Diameter, thickness, and spread ratio

Random samples were selected for physical analyses. The height and diameter of the cookies were measured with Vernier caliper. The diameter of the cookies was determined by selecting four cookies, arranged next to each other, and was measured to get the average of the diameter. The measurements of diameter use the following angles; 90°, 180°, 270°, and 360° angles. The thickness of the cookies was measured by stacking four cookies above the others, restacking four times to get the average of cookies' thickness. Zoulias et al. (2000) stated that the spread ratio of the cookies can be calculated by dividing the diameter to the thickness.

Hardness of cookies

The texture profile of cookies was determined using a texture analyzer TA–XT2i (Model TAHDI, Stable Microsystem, Surrey, UK) with a load cell of 25 kg weight (AACC, 2000). The hardness of cookies was measured within 24 hours after baking using sharp cutting bladed probe-type HDP/BS blade set at a pre-test speed of 2 mm/s, test speed of 1 mm/s, post-test speed of 5 mm/s, and compression distance of 3 mm. A cookie was placed centrally beneath the cutting bladed before starting the test. The data of cookies' hardness was analyzed using Texture Expert Version 1.05 Software (Stable Micro System Ltd, Surrey, UK).

Colour analysis

The color of the cookies was measured using Chroma Meter CR-400. The Chroma meter was calibrated prior to analysis by placing the tip of measuring head flat against the white surface of the Konica Minolta calibration plate. Samples were placed vertically and measurements are made directly on the top (upper) surface. The instrumental color data was reported as L*, a*, and b*, that define the color in a three-dimensional space: L* (dark - light), a* (redness – green) and b* (yellowness – blueness).

Sensory Evaluation

A group of 30 semi-trained panelists comprising of students of Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin, Besut, Terengganu, Malaysia evaluated the sensory of the cookies by using the seven-point hedonic scale as described by Ho and Abdul Latif (2016) with some modifications. The samples were prepared in identical sample containers, coded with 3-digit random numbers and each sample was presented with a different number. The randomized order of the sample was presented once at a time to each panelist. Panelists were asked to evaluate the coded samples for each sensorial parameter including appearance, color, aroma, texture, flavor, and overall acceptability based on their degree of liking (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).

RESULTS AND DISCUSSION

Physical Properties

The physical characteristics (weight loss, diameter, thickness, and spread ratio) of four types of cookies are presented in Table 2. Results showed that there were significantly different ($p < 0.05$) between MTF0 and other samples in terms of weight loss, diameter, thickness, and spread ratio.

It was observed that MTF0 (control) yield higher weight loss compared to other samples. The result shows a decreasing value of weight loss as the substitution increase from MTF5 and MTF15 samples. According to Chauhan et al. (2016), the increment of composite flour proportion in the blend leads to a decreasing trend of weight loss. This is due to the protein content of composite flour in which the higher the protein content, the higher the water holding capacity. It functions during the baking process to retain the components and moisture content inside the baked goods. This also depends on the protein content inside the wheat flour itself. It can be seen that the lower the protein contents inside the flour, the more the loss of the cookie its weight. The increasing proportion of MTF for 15% may indicate that the flour itself can retain the components inside the cookies during the baking process.

For diameter, it affected significantly with the substitution of immature MTF0 to MTF5 cookies. However, as the percentage of immature MTF increases, no significant changes in diameter is obtained. Jessica (2013) reported that gluten inside the baked products helps to give texture (shape) for it. In this study, the substitution of immature MTF into wheat flour does not contribute any significant results. The immature MTF may have low protein content after baking and does not contribute enough to form a gluten network with wheat flour.

The thickness of cookies increased when wheat flour was substitute with immature MTF. Nevertheless, the results obtained show no significant difference as the percentage of immature MTF increased. According to Laguna et al. (2011), the development of structure is often known as oven spring as it relates to the thickness of the baked cookies. The changes to the dough piece that are involved include the release of gases from leavening chemicals, evaporation of moisture from the product surface followed by a movement of internal moisture molecules to the surface.

Table 2: Physical properties of wheat-immature MTF blend cookies

Samples	Weight Loss (g/100g)	Diameter (mm)	Thickness (mm)	Spread ratio
MTF0	36.35^{c}±3.6	13.12^{a}±0.2	4.39^{a}±0.1	2.99^{b}±0.1
MTF5	24.97^{b}±2.9	13.59^{b}±0.2	4.95^{b}±0.2	2.75^{a}±0.1
MTF10	19.41^{a}±1.7	13.56^{b}±0.3	4.87^{b}±0.3	2.80^{a}±0.2
MTF15	16.68^{a}±2.3	13.62^{b}±0.2	4.77^{b}±0.1	2.78^{a}±0.2

The spread ratio of cookies also did not show any significant difference between the samples when wheat flour was substituted with immature MTF. According to Arti Chauhan (2016), the cookies produced from low viscosity dough spread at a higher rate. From Table 2, it shows that MTF0 has higher weight loss compared to other samples. Therefore, it should spread less due to low moisture content inside the cookies after baking. Noor Aziah (2012) reported that cookies spread at a low rate due to high viscosity content in the dough. It happens because of less water available in the dough to dissolve the sugar. This will increase the dough viscosity and the cookies will spread at a slower rate during baking.

Color analysis

The color measurements of the composite cookies substituted with different levels of immature MTF are shown in Figure 1. The results show that the lightness (L*) of the composite cookies decreased with the increasing of immature MTF substituted in the formulation. Higher levels of substitution produced a darker color of cookies. The L* value also indicates a Maillard reaction that occurs during the baking process. Chevallier et al. (2000) stated that the Maillard reaction responsible for color formation. The Maillard browning and caramelization of sugar are two important processes in cookies as it produces brown pigments on cookies during baking (Laguna et al. 2011). Milk powders also contribute lactose which is a reducing sugar that reacts with amino groups in the Maillard reaction (Cheng & Bhat, 2016).

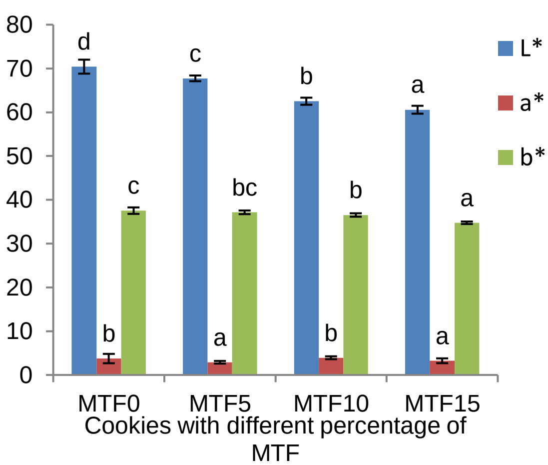

Figure1: Colour of cookies made from different percentages of immature MTF

On the other hand, there is a significant difference in a* value between those samples. The a* value indicates the red (positive value) or green color (negative value). The a* value for MTF0 is similar to a* value of MTF10. Whereas, the a* value of MTF5 similar to

MTF15.

The b* value indicates yellowness to blueness. The substitution of MTF with wheat flour (MTF10 and MTF15) resulted in a significantly lower b* value compare to the MTF0. Those values obtained refer to the pigment that may present on the cookies that came from immature MTF itself.

Hardness of cookies

Table 3 shows the texture result of the four types of cookies prepared from a blend of wheat flour and immature MTF. There are significantly different in the hardness of all MTF cookies as compared to MTF0. MTF0 yields higher force to break the cookies compare to others. For MTF5 and MTF10, there is no significant difference in terms of their hardness. Meanwhile, MTF15 yield the least force for the cookies to break. Textural characteristics of cookies are among of the most significant quality parameters that affect consumers' acceptance. The substitution of MTF in cookies affects the hardness of cookies. Difference trend was observed by Ajila (2007) where the increasing of substitution mango peel flour increased the hardness of soft dough biscuits. The decrease of hardness in cookies with MTF substitution could be due to the variations in gluten content. Torbica et al. (2010) reported that the crucial component in wheat flour is gluten, which influences the textural characteristics in bakery products. Increasing the ratio of MTF will reduce the gluten in cookie dough, thus delaying the formation of gluten matrices, thus, leads to a decrease in hardness.

Table 3: The hardness of cookies made from a different percentage of immature MT flour

Samples	Hardness (kg)
MTF0	2.97^{c}±0.5
MTF5	2.44^{b}±0.2
MTF10	2.19^{b}±0.4
MTF15	1.50^{a}±0.2

Sensory evaluation

The sensory scores of wheat–immature Manis Terengganu composite cookies are shown in Table 4. The score decreased with the increasing substitution of immature MTF into cookies. For the color of the cookies, as the percentage of immature MTF increased, the score range was significantly decreased. The color of the cookies plays an important role for panelist acceptance before evaluating to other attributes. An increasing percentage of MTF contributes to a slightly darker color of cookies.

For aroma attributes, MTF cookies were significantly lower with the substitution of wheat flour. The panelists were preferred MTF0 than other percentages of immature MTF cookies. However, the aroma score among the different percentage of MTF cookies did not shows any significant difference. According to Singh et al. (2014), an enzyme reaction may occur when substitute wheat flour with immature fruits (e.g. immature banana) during baking in which contribute a strong unpleasant odor or the condition (storage) of the composite flour itself.

The texture attributes of MTF cookies show a decreasing score. This related to Table 3 in which the hardness of cookies was decreased with the increment of MTF.

On the other side, the flavor score of MTF incorporated cookies was significantly lower compared to control cookies. This was attributed to the increasing substitution of MTF cause the formation of tart or bitter taste in MTF10 and MTF15. There was a significant difference in overall acceptability for cookies.

Overall, the panelists preferred control cookies than immature MTF incorporated cookies. This finding was contradicted with the study conducted by Chauhan et al. (2016) who stated that cookies prepared from 60% amaranth flour had the most acceptable sensory attributes. Therefore, the presence of dark color surfaces, strong aftertaste, and unpleasant odor may contribute to the unacceptability of the cookies by panelists.

Table 4: Sensory evaluation of cookies

	Control	MTF5	MTF10	MTF15
Colour	5.97^{c}±0.7	4.97^{b}±1.2	4.80^{ab}±1.3	4.07^{a}±1.3
Aroma	6.43^{b}±0.7	4.53^{a}±1.4	4.27^{a}±1.1	3.77^{a}±1.5
Texture	6.17^{c}±0.7	5.23^{b}±1.1	4.53^{ab}±1.3	4.00^{a}±1.7
Flavour	5.97^{b}±0.8	4.60^{c}±1.4	3.70^{a}±1.4	3.03^{a}±1.3
Overall accept-ability	6.30^{c}±0.7	5.00^{b}±1.1	4.03^{a}±1.4	3.23^{a}±1.5

CONCLUSION

This study revealed that the increasing percentages of immature MTF affect the physical properties of cookies such as weight loss, color, and hardness. Whereas, for diameter and thickness, does not contribute any significant results. The level substitution of immature MTF for sensory evaluation provides significant results as the level increase, more consumers did not prefer it. This is due to the strong aftertaste and the presence of 'immature fruit' taste and aroma.

CONFLICT OF INTEREST

The authors declared that the present study was performed in the absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Muhamad N and Yasuhimi NH designed this work and participated in manuscript writing. Ho LH and Noroul AZ participated in designed this work. Yasuhimi NH performed the experiments with all its analysis. All authors reviewed and approved the final version.

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