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Sensory Preference, Nutrient Content, and Shelf Life of Moringa Oliefera Leaf Crackers Rita Ismawati#,1, Meda Wahini#,2, Ita Fatkhur Romadhoni#,3, Qory Aina* # Department of Home Economics, Universitas Negeri Surabaya, Surabaya 60231, East-Java, Indonesia E -mail :1ritaismawati@unesa.ac.id; 2medawahini@unesa.ac.id; 3itaromadhoni@unesa.ac.id *Department of Nutrition Science, Surabaya College of Health Sciences, Surabaya, East-Java, Indonesia E mail: qorry.aina@stikessurabaya.ac.id Abstract— Crackers is one of the snack foods, which can be variated in various types of and flavors.

This study aimed to determine the sensory preference, nutrition content, and shelf life of Moringa oliefera leaf (Mol) crackers. Utilization of Mol is by processed it into powder, and chopped form then added to the crackers dough with the various amount of 3%, 5%, 7% and 9% for each form. The sensory test had been done to measure sensory properties such as color, aroma, texture, flavor and the level of preference.

Sensoric test data were analyzed by using two way ANOVA and further Duncan test to examine the correlation between Moringa oliefera processed leaf type and addition amount with its sensory properties and panelist's preference. The most preferred product then tested for its nutrient content. Crackers shelf life that observed were Total Plate Count (TPC) and Most Probable Number (MPN).

This study showed that Moringa oliefera processed leaf type and the additional amount that is used will affect the sensory properties of crackers. There was a correlation between the Moringa oliefera processed leaf type and addition amount that is used with the cracker's color, texture, and level of preferences, but not with the aroma and flavor. Nutrient content per 100g of the most preferences Moringa oliefera leaf crackers is

energy 368.80 kcal, carbohydrate 65.91 g, protein 11.82g, fat 6.92g, Fe 4.68mg, calcium 26.50mg, Vit C 17.88mg, Vit A 48.55SI, Fiber 4.56g, ash 5.11%, and water 1.21%.

The moringa leaf crackers can be stored for 8 weeks which TPC score is 0.9 x 104 (cfu/g) and MPN score is 23.89/g. Keywords—moringa oliefera; crackers; sensory analysis; nutrition. I. INTRODUCTION C rackers are one of the snack foods [1], that belong to a special group of dry long shelf life biscuits with most of the dough's fermented with yeast [2]. Crackers are saltine and low in sugar, thin and crisp.

Usually, sponge-and-dough method involving longer periods of dough fermentation (up to 24 hours) is used in the production. After fermentation, the dough is laminated while layers of fat are rolled in, which contributes to flaky cracker structure [3]. Crackers as one of snacks are easily found in the market with various types and flavors.

There are three major types of crackers: cream crackers, soda crackers and savory crackers [2]. Nowadays, there are various flavors of crackers such as salty, sweet, or cheese, and also supplemented with shredded, vegetables, and seaweed. Therefore, it can be indicated that crackers become one of the most popular snacks in our society.

Diversification of the crackers with different types of flavors and the addition of other ingredients will affect its sensory properties, nutrition content and its shelf life [4]. The addition of Moringa oliefera leaf (Mol) on crackers can improve crackers' nutrition content, and the utilization of Mol is not widely used in processed foods yet (Figure 1).

Fig 1 M oringa leaf Moringa known as the miracle tree or magical tree because of it is scientifically proven that the leaves of this plant can contribute significantly to the daily recommended allowance needed for many vitamins and mineral needs as well as serve as a rich source of polyphenols [5]. It confirms the importance and role that Moringa can play to improve the health and nutrition particularly in malnourished populations [6], [7].

Mol contain vitamin A, vitamin C, vitamin B, calcium, potassium, iron and protein in very high numbers which is very easily digested and assimilated by the human body [8], as well as dietary fiber, moisture and dye chlorophyll of Moringa are very helpful for human health [9] the studies prove that Moringa did not contain harmful substances to the body [10].

Moringa leaf has been purported to be a good source of nutrition and a natural organic health supplement that can be used in many therapeutic ways [11]–[13]. The desirable nutrient content in M oringa leaf can be taken in various ways such as by chopped and powdered. Mol powder made from young leaves which are picked from the first leaf

stalk (under the top) until the seventh leaf stalks of branches which is still green and have not to turn to yellow. Furthermore, the leaves are washed with clean water and then taken out of the leaf stalk, drained on a wire net.

The leaves then dried in an oven at 45oC temperature for approximately 24 hours (already quite dry). The dried leafs then mashed using the blender and sieved with 500 mesh sieve to separate small rods which cannot be crushed in a blender, then stored in an airtight plastic container [14]. Chopped Mol can be done manually using a knife, finely chopped up to produce fine pieces evenly.

This objective of the research is to see the effect of the type of the M oringa oliefera processed leaf on the sensory properties, nutrition q uality and shelf-life of crackers by the addition of the various amount of Mol in the powder and chopped form to the crackers dough nutrient content and its shelf life. I I. MATERIALS AND METHODS The experiment was implemented from May to August 2016 in the laboratory of food processing in the Department of Home Economics, State University of Surabaya, Campus Ketintang Surabaya.

The independent variables in this study is the addition of Moringa leaf in the form of chopped and powder that consist of eight treatments: P1 (Mol powder 3%), P2 (Mol powder 5%), P3 (Mol powder 7%), P4 (Mol powder 9%), P5 (chopped Mol 3%), P6 (chopped Mol 5%), P7 (chopped Mol 7%), P8 (chopped Mol 9%). The dependent variable in this study is the sensory properties including color, aroma, texture, flavor and level of preference.

Control variables are the type, quality and quantity of ingredients (flour, yeast, baking powder, powdered sugar, butter, margarine, skimmed milk, salt, and water), the equipment that is used, the process and the time of manufacture. The materials used for the analysis of nutrient content were aquades, ion-free water, n-hexane, HCl, selenium-mix, concentrated H_2SO_4, concentrated HNO_3, NaOH, boric acid, and vanadate-molybdate solution.

The tools used are slicer, tray, cabinet dryer, discmill, mixer, steam cattle jacket, piping equipment, scales, ovens, and atomic absorption spectrophotometry. Analysis of physical properties and nutrient content was carried out on the final selected crackers and controls. Physical properties analysis tested are hardness/texture, water absorption, and density of Kamba.

The nutritional content analysis includes proximate analysis and analysis of mineral content. Proximate analysis carried out is an analysis of water content, ash content,

protein content, fat content, and carbohydrate levels. Analysis of mineral content carried out is the levels of Ca, Fe, and P.

Sensory analysis is conducted with 45 panelist comprising of 15 trained panelists and 30 passable trained panelists. Panelists were required to evaluate the sensory properties including color, aroma, texture, flavor and level of preference. The data then analyze statistically at a 5% significance level using two way ANOVA.

Mean score values of the crackers' sensory properties were subjected to Duncan test to examine the correlation between Moringa processed leaf type and addition amount with its sensory properties and panelist's preference. The most preferred product then tested for its nutrient content includes energy, carbohydrates, protein, fat, Fe, calcium, vitamin C, vitamin A, fiber, ash, and moisture content. The shelf life is examined up to 2 months with a microbial test and the alteration of sensory properties during the time. III.

RESULT AND DISCUSSION A. Organoleptic Test 1) Colour The most preference Moringa oliefera leaf crackers are expected to have light-yellow color criteria. The organoleptic test showed the average score from 1.64 to 3.19. T he average score of 1.64 was obtained from the product with 9% addition of chopped Mol (P6), which is produced light-yellow color crackers with many green freckles.

Meanwhile, the average score of 3.19 was obtained from the product with 3% addition of chopped Mol (P5), which is produced light-yellow color crackers with few green freckles. The result can be illustrated in Figure 2.

0 1 2 3 4 5 addition 3% addition 5% addition 7% addition 9% addition of chopped moringa oliefera leaf and moringa oliefera leaf powder AVERAGE SCORE OF MORINGA OLIEFERA LEAF CRACKERS'S COLOUR Fig 2. The Average Score of Moringa oliefera Leaf Crackers' Colour The analysis by two way ANOVA test showed that the addition of Moringa oliefera leaf into the crackers both in forms of chopped and powder affect the crackers' color with $p = 0.00$ ($<a = 0.05$).

Furthermore, there is a correlation between the addition of chopped and powder Mol and the amount of the leaf itself to the change of the crackers' color with $p = 0.041$ ($< a = 0.05$). Five aspects contribute to color variation in our food. One of them is the natural pigment that is consist of leafy green that is called chlorophyll (the green substance in plants) [15].

Thus, with the chlorophyll from the leaf, the increase of powder and chopped leaf's addition amount will produce a darker color and result in more freckles on the crackers.

The result of ANOVA test was then further correlated with the Duncan test on the addition amount of both powder and chopped Mol, and the score is 3.78 that was obtained from the 3% addition in which produce green and light-yellow color crackers with few green freckles.

Meanwhile, the addition of the leaf as much as 5-9% result in the score as follow 2.67, 2.2, and 1.62, which produce darker green color and more freckles. B. Aroma The aroma criteria that is desired from the most preference Moringa oliefera leaf crackers is savory with a little Moringa oliefera leaf's scent. Based on the result of the organoleptic test, the average score is 1.51 to 3.33. The average score of 1.51 was obtained from the 7% addition of the chopped Mol (P7) which produce less-savory and less- Moringa oliefera scent. On the other hand, the average score of 3.33 was obtained from the 3% addition to chopped Mol (P5) which produce the savory, and a little Moringa oliefera- scented crackers.

Further results are presented in Figure 3. 0 2 4 6 addition 3% addition 5% addition 7% addition 9% addition of chopped moringa oliefera leaf and moringa oliefera leaf powder AVERAGE SCORE O F MORINGA OLIEFERA LEAF CRACKERS'S AROMA Fig. 3.

The Average Score of Moringa oliefera Leaf Crackers' Aroma The analysis by two way ANOVA test showed that the addition of Moringa oliefera leaf into the crackers both in forms of chopped and powder affect the cracker's aroma with $p= 0.00$ ($<a = 0.05$). However, there was no correlation between the addition of chopped and powder Mol and the amount of the leaf itself to the change of the crackers' aroma, w hich is shown with $p= 0.065$ ($>a = 0.05$). This result is the opposite of the theory that more Mol leaf powder mixed into the crackers, the more Mol aroma will be produced.

The Moringa oliefera is a plant with multiple leaves in its stalk. It also has long stalk with alternipinnate leaves and has a lone terminal leaflet (imparipinnate). The young leaf is yellow-greenish and turns dark green when it is grown. The leaf shape resembles an egg, with 1-2 cm long, 1-2 wide, slim, flexible, dull point and base (obtuse), flat edge, with a pinnate bone, soft upper and lower surface, and exclusive aroma [16]. The Moringa oliefera leaf powder has a very strong unpleasant leaf scent [17].

Duncan test result of the addition of both chopped and powder leaves shows the average score of 2.60 and 2.46 that is obtained from 3% and 5% Mol addition which produces s avory and little Moringa oliefera-scented crackers in the second subset. Meanwhile, with the addition of 7% and 9% of the Mol, the score were 2.09 and 2.04 which produce little savory and a little Moringa oliefera-scented crackers in the first subset.

To examine the effect of powder or chopped Mol addition on the crackers aroma, further Duncan test concerning the kinds of fat on the crackers aroma was carried out. The result is presented in Table 1. TABLE I FURTHER TEST ON THE ADDITION OF MORINGA OLIEFERA LEAF POWDER AND MORINGA OLIEFERA CHOPPED LEAF ON MORINGA OLIEFERA CRACKERS' AROMA Duncan (a,b) Addition Number N Subset 1 2 7% 90 2.04 9% 90 2.09 5% 90 2.46 3% 90 2.60 Sig. .707 .222 C.

Flavor The most preference Moringa oliefera leaf crackers are expected to have savory with a little Moringa oliefera flavor. The result of the organoleptic test shows the average score from 1.24 to 3. The score of 1.24 was obtained from 9% addition of Moringa oliefera leaf powder (P4) and produce less-savory and little Moringa oliefera-flavoured crackers.

Meanwhile, the average score three was obtained from the 3 % addition of chopped Mol (P5) that produce savory and little Moringa oliefera-flavoured crackers, as presented in Figure 4. Fig. 4. The Average of Moringa oliefera Leaf Crackers' Flavor The analysis by two way ANOVA test showed that either chopped or powder leaf used in addition affects the Moringa oliefera leaf crackers' flavor with $p = 0{,}00$ ($< a = 0.05$).

However, there was no correlation between the addition of powder and chopped Mol with the amount of the leaf itself to the change of the crackers' flavor, which is shown by $p= 0.12$ ($< a = 0.05$). Therefore, the result is opposite to the theory that kinds of the processed leaf that is added will affect the crackers' flavor. The more Mol powder being added, the flavor turns more like the Mol but reduces its tastiness.

Flavour is indeed a crucial parameter in customers' acceptability towards a product. It is different from the aroma, and it attracts the consumers from their tongue. Several factors affect flavor, as follows chemical substance, temperature, concentration, and the relation between other flavour substances [18]. Mol has its flavor because of its tannin substance.

This substance is mostly found in nature and available in every part of plants especially among the tropical plants and the tree bark. Tannin is responsible for the bitter taste because it will form across bond with either protein or glycoprotein in our mouth and produce dry and stiff taste [19]. There is about 14% tannin consisted of the Moringa oliefera leaf [20]. D.

Texture The most preference Mol crackers are expected to have crispy with multiple layers of texture. Based on the organoleptic test, the average score from 1.2 to 3.14 was

obtained. The average score of 1.2 shows the addition of Mol powder by 7% which produce fewer crispy crackers with multiple layers. Meanwhile, the average score of 3.24 is obtained by adding 3% chopped leaf which produce crispy crackers with multiple layers, as presented in Figure 5. Fig.5

The Average Score of Moringa oliefera Leaf Crackers' Texture The analysis by two way ANOVA test showed that the addition of different kinds of the Moringa oliefera's processed leaf would affect the crackers' texture with p = 0.00 (< a = 0.05). The amount of leaf addition both in the form of chopped and powder affects the texture of the crackers with p=0.00 (< a = 0.05).

There is a correlation between the addition of and powder and chopped Mol with the amount of the leaf itself to the change of the crackers' texture with p = 0.01 (< a = 0.05). The texture is affected by the humidity in a dough. The less humid a dough is, the tougher it is, which prevents the dough from expanding and creating the layers and making it not crispy [21].

A large number of Mol powder addition will make the crackers fail to expand and not crispy. This is also due to the decreasing humidity in the dough because Mol powder absorbs the water inside the dough. E. Sensory Preferences The expected sensory preferences criteria from the crackers are the "preference" criteria.

The result of the organoleptic test shows that the average score from 1.07 to 3.27. The average 1.07 is obtained from the addition of M oringa oliefera powder by 5% and 7% (P2 and P3), which results as "no preference." Nevertheless, the average score of 3.42 is obtained from the addition Mol by 3% of a chopped leaf (P5) with the criteria "pretty-well preference," as presented in Figure 6.

The analysis by two way ANOVA test showed that the addition of Moringa oliefera leaf both in the forms of powder and chopped affect the level of preferences with p =0.00 (< a = 0.05). The amount of the Mol added also affects the level of preferences with p= 0.01 (< a = 0.05). Sensory visual of the product are displayed in Fig. 7.

0 1 2 3 4 addition 3% addition 5% addition 7% addition 9% addition moringa leaf chopped and moringa leaf powder AVERAGE SCORE O F MORINGA LEAF CRACKERS'S PREFERENCES Fig. 6. The Average Score of Moringa oliefera Leaf Crackers' Preferences There is a correlation between the addition of powder and chopped Mol and the amount of the leaf itself to the panelist's preferences with the p score 0.01 (< a = 0.05).

Thus, the final result of the preference Mol crackers is crackers that has sensory criteria

such as green, but not black, light-yellow, little freckles, savory and little Moringa oliefera-scented crackers with crispy and multiple layer texture. F. Nutrient Content of Moringa Oliefera Leaf Crackers The analysis of the nutrient content of Moringa oliefera leaf crackers was carried out on the best product based on the organoleptic test (P6) with the addition of chopped leaf by 5%. The nutrient content is presented in Table II.

TABLE II MORINGA OLIEFERA LEAF CRACKERS NUTRIENT CONTENT PER 100 GRAMS Nutrient Amount Energy 368 Cal Protein 11.82 gram Fat 6.92 gram Carbohydrate 65.91 gram Calcium 26.50 mg Iron 4.68 mg Vitamin A 48.55 mg Vitamin C 17.88 mg Ash 5.11% Fiber 4.56% Water 1.21% In line with Indonesian National Standard (SNI. 01-2973- 1992), the crackers must have maximum level 4 of humidity and level 6 for minimum protein content. The Moringa oliefera leaf crackers have 1.21 humidity and 11.82 protein. The moisture content is generally low, and this is an indication of stable shelf life if properly packaged and stored [22].

Little ash and fats but high protein and carbohydrate contents of the Moringa crackers confirm with the nutritional component of wheat flour, as the main ingredient of the formula, where carbohydrate is mainly the nutritional component, and flour's protein content that used to make crackers is approximately 9-11% [23]. While the highest vitamin content is vitamin A, obtained from Moringa leaf that is a prosperous source of vitamin A [8] Therefore, it can be concluded that these crackers are qualified the SNI standard and also contains some nutrients such as iron, calcium, vitamin A and C that needed by our body.

Based on data, Mol's fiber content is quite high, so it can be considered as healthy food that recommended to consume. Because tt has been reported that a diet low in fiber is undesirable as it could cause constipation and that such diets have been associated with diseases of the colon like piles, appendicitis, and cancer [24]. G.

Moringa Oliefera Leaf Crackers Shelf Life TABLE III MORINGA OLIEFERA LEAF CRACKERS' SHELF LIFE Shelf life TPC score (cfu/g) MPN score (/g) 0 day 0.09 x 104 ± 0.39 x 107b 1.60±0.60b 2 week 0.4 x 104 ± 0.92 x107b 2.57±0.92b 4 week 0.7 x 104 ± 4.02 x 107b 4.00±1,66b 6 week 0.8 x 104± 8.54x 107b 14.60±4.67b 8 week 0.9 x 104 ± 17.36 x107b 23.89±9.78b The result on Total Plate Count (TPC) as presented in the table shows that the TPC score has positive results with the crackers shelf life.

The longer it stored, the higher its TPC rate is. The highest TPC rate is obtained from the crackers that are stored for 8 weeks, which the score is 0.9 x 104 (cfu/g). The interval of keeping from 0 day to 8 days does not exceed SNI's maximum limit, which the score is 1.0 x 104 cfu/g. This can be because of the low water content in Moringa aliefera leaf

crackers that can affect its moisture.

As known, moisture determination is one of the most common tests in foods since the water content in foods has an important relationship between conservation and the chemical, physical and microbiological changes during the storage [25]. Fig 7. P1 (Mol powder, 3% addition), P2 (Mol powder, 5% addition), P3 (Mol powder, 7% addition), P4 (Mol powder, 9% addition), P5 (Chopped Mol, 3% addtion), P6 (Chopped Mol,, 5% addition), P7 (Chopped Mol, 7% addition), P8 (chopped Mol, 9% addition) The score of MPN on Moringa oliefera leaf crackers with its various length of shelved increases along with its length of shelved [26]. Keeping crackers for eight weeks results in the highest MPN score, which counts 23.89/g.

This score is still below the maximum level of SNI's MPN score, which is 20/g. Based on the analysis that had been done, it showed that there is a correlation between the lengths of keeping the crackers with the MPN score. Figure 6 shows the TPC and MPN scores of Moringa oliefera leaf crackers which increases every week [27]. IV.

CONCLUSION This study has shown that the type and the amount of the Moringa oliefera processed leaf that is used will affect the sensory properties such as color, aroma, flavor, texture and the level of preferences. The best result is obtained from the crackers which used 5% of chopped Moringa oliefera leaf with the color criteria "light-yellow with little green freckles," the aroma of "savory and little Moringa oliefera-scented, the texture of "crispy enough with multiple layers," the flavor of "savory and little Moringa oliefera-flavoured."

The nutrient content in each 100 grams of the most preference crackers is 368.80 kcal energy, 65.91g of carbohydrate, 11.82 g of protein, 6.92 g of fat, 4.68 mg of Fe, 26.50 mg calcium, 17.88 mg vitamin C, 48,55SI vitamin A, 4.56g fiber, 5.11% of ash content, and 1.21% of water content. The highest crackers' shelf life rate from the TPC is obtained from the Mol crackers that are kept for 8 weeks with 0.9 x 104 (cfu/g).

The length of its keeping is from day 0 to 8 weeks and does not exceed the maximum limit from SNI (1.0 x 104 cfu/g). The highest MPN score on the Mol crackers that are kept for eight weeks is still below the maximum level of SNI's MPN crackers' content (20/g). ACKNOWLEDGMENT Our deepest gratitude is for the Ministry of Research, Indonesian Science and Higher Education who have funded this research from the Penelitian Unggulan Tinggi (UPT- IDB) Universitas Negeri Surabaya. P3 P4 P5 P6 P7 P8 P1 P2 REFERENCES [1] Lusas, E. W. (2001). Overview. In E.W. Lucas & L.W. Rooney (Eds.), Snack Foods Processing. Boca Raton: CRC Press LLC [2] Manley, D. 2000. The technology of biscuits, crackers, and cookies.

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