

EFFECT OF ADDITIONAL FLOUR OF MORINGA OLEIFERA (*Moringa oleifera*) ON ORGANOLEPTIC AND CHEMICAL PROPERTIES OF TEMPE NUGGET**Exlesia Fininta Sinaga^{1)*}, Tineke M. Langi²⁾, Teltje Koapaha²⁾**¹⁾Food Technology Study Program, Faculty of Agriculture Sam Ratulangi University, Manado.²⁾ Lecturer of Agricultural Technology Department, Faculty of Agriculture Sam Ratulangi University, Manado., Jl. Kampus Unsrat Manado, 95515 Telp (0431) 846539

*Corresponding author:

exlesia.sinaga8008@gmail.com**Abstract**

The purpose of this study was to determine the amount of addition of moringa leaf flour to the panelists' most preferred tempeh nuggets, analyze the antioxidant content in the most preferred treatment and analyze the water content, protein content, fat content. This study used a Completely Randomized Design (CRD) method consisting of five (5) treatments with three (3) replications with the addition of Moringa leaf flour as follows: Treatment A 0.5% moringa leaf flour, Treatment B 1% Moringa leaf flour, Treatment C 1.5% moringa leaf powder, Treatment D 2% moringa leaf powder, Treatment E 2.5% moringa leaf powder. The results obtained showed that the addition of 1.5% Moringa leaf flour was the most preferred by the panelists with the antioxidant activity produced which was classified as strong, namely 99.70 ppm. The value of water content (17%-30%), protein content (17.21%-24.22%), and fat content (1.45%-7.61%).

Keywords: *nuggets, tempeh, moringa leaves.***INTRODUCTION**

Nuggets are generally made from processed chicken meat, which is high in fat and low in fiber. Nugget is a ready-to-eat food whose processing process goes through the stage of steaming the dough which is then stored in the refrigerator before being fried to be served. In the steaming process it will become starch gelatinization and protein changes will form a network like a matrix.

One of the efforts to develop nuggets that have high nutritional content is by utilizing vegetable ingredients.

Tempe is a fermented food product from soybeans which is rich in protein, iron, calcium, dietary fiber, and B vitamins and antioxidants. The protein in tempeh is 20.08 g per 100 g. Tempe has antioxidant activity content of 68.63%-81.43% depending on the variety of soybean used (Istiani, 2010).

Moringa leaf is a local food ingredient that is believed by the community to have high nutritional

content, but its utilization is not optimal. Fresh Moringa leaves that are used as flour contain 23.37% protein in 100 g and antioxidant compounds around 239.42 ppm such as tannins, steroids, triterpenoids, phenolics, flavonoids, saponins, and alkaloids (Putra et al, 2016) which are good added in food products to increase nutritional value.

RESEARCH METHODS

This research was conducted at the Food Processing and Analysis Laboratory, Faculty of Agriculture, Sam Ratulangi University, Manado for 3 months.

Materials And Tools

The ingredients used are tempeh (obtained from the A-zaki Tempe Factory in Kleak Manado Village), Moringa leaf flour (obtained from Jalan Sea, Manado), wheat flour (blue triangle), cooking oil (sania), breadcrumbs flour (mama likes it), salt (dolphin), water, shallots, garlic, flavoring, aquades, H₂SO₄, NaOH, HCl,

methyl red, potroleum ether, ethanol, methanol, DPPH.

The tools used are analytical scales, containers, blenders, stoves, cutting boards, baking sheets, stoves, cauldrons, knives, spatulas, measuring flasks, beakers, test tubes, test tube racks, vials, measuring cups, beakers, dropper drops, glass funnels, petri dishes, kjedahl flasks, electric heaters, distillers, desiccators, aluminum foil, filter paper and spectrometers.

Research Design

The method used in this study was a completely randomized design (CRD) method consisting of 5 treatments and 3 replications with the addition of Moringa leaf flour as follows:

- A = 0.5 %
- B = 1%
- C = 1.5%
- D = 2%
- E = 2.5%

Research Procedure

Making Moringa Leaf Flour (Kurniawati et al, 2018)

Fresh Moringa leaves are separated from the stalks, then washed, drained, then dried in the sun for 4 days. After that, the dried Moringa leaves are ground using a chopper and then sieved using a plastic sieve to produce Moringa leaf flour and stored in a closed plastic container.

Making Moringa Tempe Nugget (Salsabila et al, 2022) modified

Tempeh is cut into cubes with a length of 1cm and a width of 1cm then steamed for 20 minutes and mixed with spices (shallots, garlic, salt, flavoring) then mashed using a collision. After that, 65% tempeh added with spices made a dough by mixing 35% wheat flour, added Moringa leaf flour according to the treatment (0.5%; 1%; 1.5%; 2%; 2.5%) and then added water. as much as 40 ml and stirred until homogeneous. The ready dough is put into a baking sheet that has been greased with oil. The purpose of giving oil to the pan so

that the dough does not stick when steamed. The dough is steamed for 30 minutes then the nuggets are cooled and then cut into lengths of 6cm and width of 1cm and covered with breadcrumbs. After that, the initial frying was carried out for 30 seconds with the aim of attaching the flour adhesive to the product and then freezing it.

Analysis Method

Organoleptic Test (Nugraha, 2019)

Organoleptic testing was carried out based on the level of preference using a hedonic scale. Assessment of the organoleptic quality of tempe nuggets with the addition of Moringa leaf flour included: color, taste, aroma and texture. The rating scale consists of seven levels, namely 1 (very dislike); 2 (dislike); 3 (rather dislike); 4 (neutral); 5 (somewhat like); 6 (like); 7 (very much like). The panelists consisted of 30 students from the Faculty of Agriculture, Department of Agricultural Technology, each panelist was given an assessment format and asked to give personal responses to the sample presented.

Oven Method Moisture Content (SNI 01-2891-1992)

The sample that has been weighed is mashed as much as 2 g in a petri dish that has been weighed previously and labeled. Dry in an oven at 1050°C for 3 hours, then cool in a desiccator for 10 minutes and weigh. The water content can be calculated as follows:

$$\text{Moisture content (\%)} = \left(\frac{W_2 - W_1}{W} \right) \times 100\%$$

W= Initial sample weight (g)

W1= Weight of dry sample (g)

W2= Weight of dry sample added cup (g)

Protein Content Kjedahl Method (Legowo et al, 2007)

The mashed sample was weighed as much as 1 g of the sample and then put into a labeled destruction flask. Each

sample was added with a catalyst of 25 ml H₂SO₄ and heated in a heating machine for 2 hours until the solution was greenish and allowed to cool. After the destruction process is complete, it is continued with the distillation process. Each sample was added with 5 ml of 45% NaOH solution. then reheated for 10 minutes. Furthermore, 2.5 ml of 2% boric acid was added to the sample and 2 drops of methyl red indicator were added to the sample. After that, the titration was carried out using 0.01 N HCl until the color changed to purple.

$$\text{Protein content (\%)} = \frac{(\text{ml blanko} - \text{ml HCL}) \times N \text{ HCL} \times 14,01 \times 6,25}{\text{Mg sample}} \times 100\%$$

Fat Content (SNI 01-2891-1992)

Weigh the sample that has been mashed as much as 2 g, put it into a labeled flask and add 10 ml of HCL with 20 ml of distilled water. The sample was heated with a heating machine for 15 minutes. Then filtered with filter paper that has been labeled with the addition of 5 ml of n-hexene solution. Dry the filter paper in an oven at a temperature of 100-1050c for approximately 2 hours until the weight is constant, then weighed.

$$\text{Fat Content} = \frac{\text{Weight after oven} - \text{Empty weight}}{\text{Sample weight}} \times 100\%$$

Antioxidant Activity Test of DPPH Method (Rahmawati et al, 2015)

To test the antioxidant activity using the DPPH method, the sample was weighed 0.01 mg and diluted with 10 ml of ethanol. Then the sample was divided into 5 series of solution concentrations, namely 50 (0.25 ml sample), 100 (0.05 ml sample), 200 (0.1 ml sample), 300 (0.15 ml sample), 400 (0.2 ml sample) with the addition of 2 ml of DPPH and ethanol. The mixed sample was fully covered with aluminum foil and allowed to stand for 30 minutes until a color change from DPPH activity occurred. The sample was measured its

absorbance value with a UV-Vis spectrophotometer with a wavelength of 517 nm. Antioxidant activity will be determined by the amount of DPPH absorption by calculating the inhibition (%) of DPPH absorption as follows:

$$\text{Inhibition (\%)} = \frac{\text{Blank absorbance} - \text{Sample absorbance}}{\text{Blank absorbance}} \times 100\%$$

Information:

Absorbance blank: DPPH radical absorption with a wavelength of 517nm

Sample absorbance: sample absorption in the DPPH radical with a wavelength of 517 nm

The IC₅₀ value of each sample concentration was calculated using the linear regression equation with the x-axis of sample concentration and the y-axis of % inhibition. The formula for determining the IC₅₀ value is: $IC_{50} = \frac{50-a}{b}$

RESULTS AND DISCUSSION

Color Likeness Level

The results of observations of the panelists' preference for the color of tempeh nuggets with the addition of Moringa leaf flour ranged from 3.8 to 4.66 (neutral-slightly like) in Table 1.

The average vale of panelists' preference for the color of tempe nuggets with the addition of Moringa leaf flour showed that treatment C (1.5% Moringa leaf flour) was at the most favorable level. From the results of analysis of variance ($\alpha = 0.05$) tempe nuggets with the addition of Moringa leaf flour, the f value is smaller than f table which shows no significant effect of each treatment on the color level of tempe nuggets with the addition of Moringa leaf flour, so it does not followed by the LSD test. Panelists gave an assessment that the color of tempeh nuggets was attractive with the addition of Moringa leaf flour. The color produced from tempe nuggets is white with green spots. The chlorophyll content contained in Moringa leaves is high, namely 6890

mg/kg dry matter, as a green color for tempe nuggets (Hastuti et al, 2015).

Taste Likeness Level

The results of observations of the panelists' preference for the taste of tempeh nuggets with the addition of Moringa leaf flour ranged from 4.2-5.1 (neutral-slightly like) in Table 2.

The average value of the panelists' preference for the taste of tempeh nuggets with the addition of Moringa leaf flour showed that treatment C (1.5% Moringa leaf flour) was at the highest level of preference. Table The results of the analysis of variance ($\alpha = 0.05$) of tempe nugget with the addition of Moringa leaf flour showed that the calculated f value was greater than f table which showed a significant effect of each treatment, so it was continued with the LSD test. Based on the results of the 5% LSD test, it showed

that treatment A and treatment C were not significantly different, but significantly different from treatments B, D and E. Panelists' assessment of the taste of tempeh nuggets with the addition of Moringa leaf flour was somewhat favored in treatments A, B and C. Panelists gave a neutral value in treatments D and E. The taste produced from Moringa leaf flour was slightly bitter and astringent due to the tannin content in Moringa leaves (Rosyidah et al, 2016). The addition of spices with the right amount can remove the slightly bitter and astringent taste from the Moringa leaves.

Aroma Likeness Level

The results of observations of the panelists' preference for the aroma of tempeh nuggets with the addition of Moringa leaf flour ranged from 4.6 to 5.06 (slightly like) in Table 3.

Table 1. Average value of preference for the color of Moringa Tempe Nugget

Treatment	Average	Criteria
A (0,5% Moringa leaf flour)	4,56	Slightly like
B (1% Moringa leaf flour)	4,33	Neutral
C (1,5% Moringa leaf flour)	4,66	Slightly like
D (2% Moringa leaf flour)	4,16	Neutral
E (2,5% Moringa leaf flour)	3,8	Neutral

Table 2. Average Preference Value of Nugget Tempe Moringa Flavor

Treatment	Average (*)	Criteria
A (0,5% Moringa leaf flour)	5,06 ^a	Slightly like
B (1% Moringa leaf flour)	4,56 ^b	Slightly like
C (1,5% Moringa leaf flour)	5,1 ^a	Slightly like
D (2% Moringa leaf flour)	4,2 ^c	Neutral
E (2,5% Moringa leaf flour)	4,4 ^d	Neutral

LSD 5% = 0.11 (*) Different notations indicate a significant difference.

Table 3. Average Preference Value for the Aroma of Moringa Tempe Nuggets

Treatment	Average	Criteria
A (0,5% Moringa leaf flour)	5,06	Slightly like
B (1% Moringa leaf flour)	4,8	Slightly like
C (1,5% Moringa leaf flour)	5,03	Slightly like
D (2% Moringa leaf flour)	4,6	Slightly like
E (2,5% Moringa leaf flour)	4,63	Slightly like

The average value of the panelists' preference for the aroma of tempeh nuggets with the addition of Moringa leaf flour showed that treatment A (0.5% Moringa leaf flour) was at the highest level of preference. Table The results of analysis of variance ($\alpha = 0.05$) of tempe nugget with the addition of Moringa leaf flour showed that the calculated *f* value was greater than *f* table which showed no significant effect of each treatment, so it was not continued with the LSD test. The aroma generated from the nuggets is tempeh and Moringa leaf flour. Moringa leaf flour has a distinctive sharp aroma, caused by Moringa leaves which have lipoxidase enzymes (Sari, 2013; Salsabila et al, 2022). The addition of spices can remove the unpleasant smell of Moringa leaves.

Texture Likeness Level

The results of observations of the panelists' preference for the aroma of tempeh nuggets with the addition of Moringa leaf flour ranged from 3.96 to 4.93 (neutral-slightly like) in Table 4.

The average value of the panelists' preference for the texture of tempe nuggets with the addition of Moringa leaf flour showed that treatment C (0.5% Moringa leaf flour) was at the highest level of preference. Table The results of analysis of variance ($\alpha = 0.05$) of tempe nugget with the addition of Moringa leaf flour showed that the calculated *f* value was greater than the *f* table which indicated that there was a significant effect of each treatment, so it was continued with the LSD test. The results of the 5% LSD test showed that treatment A was significantly different from treatment B, C, D, and E. Treatment B was significantly different from treatment A, C, D and E. Treatment C was significantly different from treatment A, B, D and E. Treatment D was significantly different from treatment A, B, C and E. Treatment E was significantly different from treatment A, B, C, and D. The

addition of Moringa leaf flour to the tempe nugget dough gave a dense and compact texture (Widyawatiningum et al, 2018). This is also due to the use of the same water in each treatment. The reduced water activity in the nuggets will cause the texture to become hard.

Water Content

The results of observations of the moisture content of tempeh nuggets with the addition of Moringa leaf flour have an average value ranging from 17%-30% which can be seen in Table 5.

Based on the results of the analysis, the highest average water content was found in treatment A (0.5% Moringa leaf flour) 30% and the lowest water content value was in treatment E (2.5% Moringa leaf flour) 17%. Based on the results of the analysis of variance (attachment 6), the calculated *f* value is greater than *f* table which indicates a significant effect on the treatment, so the 5% LSD test was carried out. Based on the results obtained, the more concentration of Moringa leaf flour is added, the water content produced will decrease. This is due to the proportion of dry ingredients, namely Moringa leaf flour, which is increasingly being used, so that the tempeh nuggets look dry. According to SNI 01-6683-2014, the maximum water content in the combination nuggets is 60%, so all treatments on tempeh nuggets with the addition of different Moringa leaf flour have met the SNI requirements because the highest water content obtained is 30%.

Protein Content

The results of observing the protein content of tempe nuggets with the addition of Moringa leaf flour have an average value ranging from 17.21%-24.22%, which can be seen in Table 6.

Based on the results of the analysis, the highest average protein content was found in treatment E (2.5% Moringa leaf flour) 24.22% and the lowest protein content in treatment A (0.5% Moringa leaf

flour) 17.21%. Based on the results of the analysis of variance, the calculated *f* value is greater than *f* table which indicates a significant effect on the treatment, so the 5% LSD test was carried out. The more concentration of Moringa leaf flour used, the higher the protein content. This is because the protein content of Moringa leaves is quite high at 23.37 g and the protein content of tempeh is also high at 20.8 g in 100 g (TKPI, 2017). According to SNI 01-6683-2014, the minimum protein

content in combined nuggets is 9%, so all treatments on tempeh nuggets with the addition of different Moringa leaf flour have met the SNI requirements, the protein content obtained is 17.21%-24.22 %.

Fat Content

The results of observations of the fat content of tempeh nuggets with the addition of Moringa leaf flour have an average value ranging from 1.45%-7.61% in Table 7.

Table 4. Average Preference Value of Moringa Tempe Nugget Texture

Treatment	Average (*)	Criteria
A (0,5% Moringa leaf flour)	4,43 ^a	Neutral
B (1% Moringa leaf flour)	3,96 ^b	Neutral
C (1,5% Moringa leaf flour)	4,93 ^c	slightly like
D (2% Moringa leaf flour)	4,6 ^d	slightly like
E (2,5% Moringa leaf flour)	4,2 ^e	Neutral

LSD 5% = 0.12 (*) Different notations indicate a significant difference.

Table 5. Moisture Content of Moringa Tempe Nugget

Treatment	Average (*)
A (0,5% Moringa leaf flour)	30% ^a
B (1 %Moringa leaf flour)	25,5% ^b
C (1,5% Moringa leaf flour)	23,5% ^c
D (2% Moringa leaf flour)	22,5% ^d
E (2,5% Moringa leaf flour)	17% ^e

LSD 5% = 1.12 (*) Different notations indicate significant differences.

Table 6. Protein Content of Moringa Tempe Nugget

Treatment	Average (*)
A (0,5% Moringa leaf flour)	17,21% ^a
B (1% Moringa leaf flour)	17,21% ^a
C (1,5% Moringa leaf flour)	18,96% ^b
D (2% Moringa leaf flour)	23,05% ^c
E (2,5% Moringa leaf flour)	24,22% ^d

LSD 5% = 1.45 (*) Different notations indicate a significant difference.

Table 7. Fat Content of Moringa Tempe Nugget

Treatment	Average (*)
A (0,5% Moringa leaf flour)	7,61% ^a
B (1% Moringa leaf flour)	5,56% ^b
C (1,5% Moringa leaf flour)	4,38% ^c
D (2% Moringa leaf flour)	2,75% ^d
E (2,5% Moringa leaf flour)	1,45% ^e

LSD 5% = 0.64 (*) Different notations indicate a significant difference.

Based on the results of the analysis, the highest average fat content was found in treatment A (0.5% Moringa leaf flour) 7.41% and the lowest fat content in treatment E (2.5% Moringa leaf flour) 1.45%. Based on the results of the analysis of variance, the calculated *f* value is greater than *f* table which indicates a significant effect on the treatment, so the 5% LSD test was carried out. The more concentration of Moringa leaf flour used, the lower the fat content. The content of antioxidants and vitamin C in Moringa leaves is high enough to inhibit fatty acid biosynthesis. According to SNI 01-6683-2014, the maximum fat content of combined nuggets is 20%, so all treatments on tempeh nuggets with the addition of different Moringa leaf flour have met the SNI requirements because the highest fat content obtained is 7.61%.

Antioxidant Activity

The results of the antioxidant activity of tempe nuggets with the addition of 1.5% Moringa leaf flour which was the most preferred by the panelists showed the IC₅₀ value with a value of 99.70 ppm which was quite strong. The antioxidant activity is very strong if the IC₅₀ value is less than 50 ppm, strong if the IC₅₀ is 50-100 ppm, moderate if the IC₅₀ is 100-150 ppm, and weak if the IC₅₀ is 151-200 ppm (Mardawati et al, 2008; Wilapangga and Sari, 2018). Moringa plants contain various free radical inhibitory molecules, such as phenolic compounds (phenolic acids, flavonoids, quinones, coumarins, lignans, stilbenes, tannins), nitrogen compounds (alkaloids, amines, betalains), vitamins, terpenoids (including carotenoids) (Karyadi, 2004). ; Rizkyanti et al, 2017). The antioxidant activity of the ethanol extract of Moringa leaves using the maceration method has antioxidant power with an IC₅₀ value of 22.1818 ppm which indicates that the ethanolic extract of Moringa leaves is very strong (Rizkayanti et al, 2017).

CONCLUSION

Based on the results of the research, the panelists preferred the addition of 1.5% Moringa leaf flour, namely the color 4.66 (slightly like), taste 5.1 (slightly liked), aroma 5.03 (slightly like), texture 4.93 (slightly like) with antioxidant activity of 99.70 ppm (strong). The results of chemical analysis of each treatment showed the average value of water content (17%-30%), protein content (17.21%-24.22%), fat content (1.45%-7.61%).

REFERENCES

- Hastuti, S., S. Suryawati & I. Maflahah. 2015. Pengujian Sensoris Nugget Ayam Fortifikasi Daun Kelor. *Agointek: Jurnal Teknologi Industri Pertanian*, 9(1):71-75.
- Istiani, Y.. 2010. Karakterisasi Senyawa Bioaktif Isoflavon dan Uji Aktivitas Antioksidan dari Ekstrak Etanol Tempe Berbahan Baku Koro Pedang. Tesis. Universitas Sebelas Maret. Surakarta.
- Kurniawati, I., M. Fitriyya & Wijayanti. 2018. Karakteristik Tepung Daun Kelor Dengan Metode Pengeringan Sinar Matahari. *Prosiding Seminar Nasional Unimus*.
- Legowo, A.M., Nurwantoro & Sutaryo. 2007. *Buku Ajar Analisis Pangan*. Fakultas Peternakan. Semarang.
- Nasional, B.S.. 1992: *Cara Uji Makanan Dan Minuman*. Badan Standarisasi Nasional. Jakarta.
- Nugraha, D.B.. 2019. Sifat Fisikokimia Dan Organoleptik Nugget Ayam Dengan Jenis Tepung Yang Berbeda. *Skripsi. Fakultas Teknologi Pertanian. Universitas Semarang. Semarang*.
- Putra, I.W.D.P., A.A.G.O. Dharmayudha & L. M. Sudimartini. 2016.

- Identifikasi Senyawa Kimia Ekstrak Etanol Daun Kelor di Bali. *Indonesia Medicus Veterinus*, 5(5):464-473.
- Rahmawati, R., A. Muflihunna & L. M. Sarif. 2015. Analisis Aktivitas Antioksidan Produk Sirup Buah Mengkudu. *Jurnal Fitoafarmaka Indonesia*, 2(2):97-101.
- Rizkayanti, R., A.W.M. Diah & M. R. Jura. 2017. Uji Aktivitas Antioksidan Ekstrak Air Dan Ekstrak Etanol Daun Kelor. *Jurnal Akademika Kimia*, 6(2):125-131.
- Rosyidah, A.Z. dan R. Ismawati. 2016. Studi Tentang Tingkat Kesukaan Responden Terhadap Penganekaragaman Lauk Pauk Dari Daun Kelor. *E-journal Boga*, 5(1):17-22.
- Salsabila, R., D. Rosmana., U. Mahmudah., W. Priawantiputri., R.N. Fauziyah & Jundra. 2022. Formulasi Dan Sifat Organoleptik Nugget Berbasis Tempe Dan Serbuk Daun Kelor Sebagai Makanan Selingan Tinggi Kalsium Untuk Lacto-Ovo Vegetarian. *Jurnal Balokdayamas*, 1(1):14-25.
- Widyawatiningum, E., S. Nur & N.C. Ida. 2018. Kadar Protein dan Organoleptik Nugget Ayam Fortifikasi Daun Kelor. <https://publikasi.polije.ac.id/index.php/prosiding/article/view/1224>. Diakses Pada 19 Mei 2022.
- Wilapangga, A. dan L.P. Sari. 2018. Analisis Fitokimia dan Antioksidan Metode DPPH Ekstrak Metanol Daun Salam. *Indonesian Journal of Biotechnology and Biodiversity*, 2(1):19-24.