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Marigold flower (*Tagetes erecta* L.) as natural food colourant in the making of wet noodle

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Abstract

Wet noodles are one type of noodle made without a drying process. Generally, wet noodles are yellow due to a reaction with alkaline salts. However, wet noodles were added with artificial colouring to give more yellow colour and increase consumer acceptance. The petals of the marigold flower (*Tagetes erecta* L.) contain carotenoid pigments that give yellow colour; thus, they can replace artificial colourants. In this research, marigold powder (MP) with various concentrations (0, 0.25%, 0.5%, 0.75%, and 1%) was subjected to wet noodles formulation. The result showed that WN3 with 0.5% MP was the preferred formulation with 1.36±0.03%, 60.97±0.66%, and 0.41% ±0.01 of carotenoid, moisture, and ash content, respectively. Cooking loss and water absorption of the WN3 were 1.05±0.06% and 91.60±4.97%. The lightness and °Hue of the WN3 are within the values of 61.85 and 88.48, which indicates a yellow-red colour. Panellists slightly like (5.46±0.85) the overall acceptance of the WN3. The degree of acceptance of colour and foreign aroma is within the range of neutral to slightly like, while for foreign taste, chewiness and stickiness are slightly like to like. Additionally, the result for the scoring test showed that WN3 had a slightly yellow colour, slightly foreign aroma, slightly less intense foreign taste, chewy, and slightly sticky. Thus, the study suggested that WN3 consisting of 0.5% MP is selected as the preferred formulation to make wet noodles.

1. Introduction

Noodles are an alternative food to rice because it contains carbohydrate. The main ingredients for noodles were wheat flour, water, and salt. The quality characteristics of noodles are firm, chewy, and elastic texture with some springiness. There are several types of noodles, such as fresh noodles, dried noodles, instant noodles, and wet noodles (Hou, 2010; Shin *et al*., 2014). Fresh raw noodles generally contain about 32-38% moisture and increase to approximately 55-60% in the final product due to the boiling or steaming process (Hou, 2010; Karim and Sultan, 2014). Wet noodle is a food product made from wheat flour as the main ingredient, salt, alkaline salts, and water allowed through without drying.

Generally, wet noodles are yellow due to a reaction with alkaline salts. However, in the manufacture of wet noodles, artificial colourings such as methyl yellow, tartrazine, and methanyl yellow are also added to give a more yellow colour. Thus, it can increase consumer acceptance. However, artificial colouring in food products can accumulate in the human body and are carcinogenic (Amchova *et al*., 2015; Ghosh *et al*., 2017).

The Marigold flower (MF) has about 33 species with *Tagetes*'s scientific name. The commercially cultivated species is *Tagetes erecta* L., native to Africa and widely used as a natural colourant of yellow. The petals of the MF contain carotenoid pigments, such as α and β carotene and xanthophylls (lutein and zeaxanthin) (Zuorro and Lavecchia, 2010). The extract from MF contains 27% carotenoid pigment (Siriamornpun *et al*., 2012; Šivel *et al*., 2014). The carotenoid pigments contained in the crown of MF are about 200 times greater than those contained in corn (Fu *et al*., 2018).

Cereals, chewing gum, dairy products, sauces, candies, baby food, processed fruits, and soups used MF as yellow colourants with levels ranging from 2 to 330 mg/kg due to a higher carotenoid content (Toliba *et al*., 2018). Norlaili *et al*. (2014) successfully developed yellow alkaline noodles by using dry and aqueous

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marigold extract. Norlaili *et al*. (2014) showed that the noodles prepared with aqueous extract were more acceptable to the panellists than the dry extract. Nevertheless, colourant in powder form is easier to make and apply than in the extract form. Therefore, in this research, MF was made into powder form with five (0%, 0.25%, 0.5%, 0.75%, 1%) different concentrations and subjected to the wet noodle's formulations. This research aimed to determine the preferred formulation for the physicochemical and sensory characteristics of wet noodles.

2. Materials and methods

2.1 Materials

Freshly bloomed marigold flowers obtained from Jakarta, Indonesia, were the primary materials used in this research to make marigold powder.

Oven (Memmert UNB 500), dry blender (Phillips), and sieve shaker (Retsch) were the equipment used to make MP. Noodle maker (Fomac), knife (Oxone), stove (Hitachi), and mixer (Phillips) were used as equipment to make wet noodles. In addition, analyses of MP and wet noodles used the following equipment: desiccator (Duran), analytical and table balance (Ohaus), glassware (Iwaki Pyrex), pH meter (Metrohm), chromameter (Konica Minolta CR 400) and granular materials attachment (Konica Minolta CR A50) for colour analysis, furnace (Thermolyne 62700), spectrophotometer (Hitachi), and texture analyser (TAXT Plus) for texture analysis.

2.2 Research method

This research used an experimental method to make wet noodles with various MP concentrations (0%, 0.25%, 0.5%, 0.75%, and 1%). The resulting wet noodles then are analysed with five replications for their physical characteristics (colour, cooking loss, water absorption) and chemical characteristics (total carotenoids content). Furthermore, the sensory characteristics, including scoring and hedonic, were analysed to determine the preferred formulation of a wet noodle.

2.2.1 Marigold powder production

Marigold powder (MP) has been made according to Toliba *et al*. (2018) and Norlaili *et al*. (2014) with modifications. The MF was sorted, cleaned, and washed with distilled water. After washing, the petals were dried in an oven at 50±5°C for 24 hrs. The dried marigold was grounded using a dry blender and sifted with a 60-mesh sieve shaker to obtain MP. The moisture content of MF and MP was analysed by using an oven method (AOAC, 2005) and calculated using the following formula:

$$\text{Moisture content (\%)} = \frac{\text{initial weight of sample (g)} - \text{final weight of sample (g)}}{\text{initial weight of sample (g)}} \times 100\%$$

Besides, colour analysis including °Hue and L* was analysed on the resulting powder and MF. The formula as follows was used to calculate the yield of MP (Farooq *et al*., 2013; Sunil and Swati, 2013).

$$\text{Yield (\%)} = \frac{\text{weight of dried marigold (g)}}{\text{weight of powder (g)}} \times 100\%$$

Analysis of the total carotenoid content of MF and MP followed according to Šivel *et al*. (2014), Siriamornpun *et al*. (2012) and Toiu *et al*. (2008) with modifications. Analysis of carotenoid content consists of making standard curves and sample analysis at 450 nm. In making the standard curve, 0.0025 g of pure carotene was weighed, then dissolved in 0.25 mL of chloroform and diluted with petroleum benzene. The diluted solution then is made to a concentration of 0.2-0.8 ppm with acetone and petroleum benzene. Blank consisted of 0.3 mL of acetone diluted with petroleum benzene to 5 mL.

A weight of 0.0010 g of sample with 5 mL of petroleum benzene and 5 mL of acetone was mixed for sample analysis. The mixture is then stirred evenly with a vortex. After that, the mixture was put into a separating funnel, added 45 mL of distilled water, and then shaken. The resulting-coloured part was put into a test tube, added 0.5 g of anhydrous Na_2SO_4 and mixed with a vortex. 0.1 mL of the sample was pipetted into a 5 mL volumetric flask and added with petroleum benzene to the mark. The sample's absorbance was measured at a wavelength of 450 nm with a petroleum benzene blank. Total carotenoid content was analysed using a formula as follows:

$$Carotenoid\ content\ \left(\%, \frac{w}{w}\right) = \frac{x\ (\frac{mg}{L})}{weight\ of\ sample\ x\ 1000\ (mg)} \times volume\ (L) \times df \times 100\%$$

Where df: dilution factors and X: taken from the regression equation of the standard curve

2.2.2 Wet noodles making

Making wet noodles begins with weighing all ingredients based on Table 1. The salt was dissolved in the water first. Wheat flour is then stirred evenly with a mixer at speed 2 for 30 s. The salt solution was added slowly and stirred for 2 mins. After that, the various MP concentrations were added to the dough and kneaded continuously for 4 mins. The dough was then flattened to a thickness of 1.5 mm. The dough was then formed into sheets on a noodle roller machine seven times in a row by resting the dough for 15 mins at room temperature after forming the fifth sheet. After that, the dough sheets formed into noodle strands with a noodle cutter. The noodle dough is boiled in water (1:10) for 3 mins and drained. The five formulations of wet noodles were then analysed, including physical, chemical, and sensory

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analyses to determine the preferred formulation.

Table 1. Wet noodles formulations.

Ingredients	Formulations (%)				
	WN1	WN2	WN3	WN4	WN5
Wheat flour	100	100	100	100	100
Water	40	40	40	40	40
Salt	1	1	1	1	1
MP	0	0.25	0.5	0.75	1

Note: %water, % salt, and % of MP based on the weight of wheat flour.
Source: Norlaili *et al.* (2014).

Physical and chemical analyses were carried out, including total carotenoid content, colour (lightness), cooking loss, and water absorption. Determination of the carotenoid content of wet noodles followed the same method and formula for the carotenoid content of the MP. The lightness value (L*) was analysed using a chromameter. The value of L* shows the degree of lightness which ranges from 0-100 (0 = black, 100 = white).

Water absorption analysis was conducted by boiling 5 g of the sample in 60 mL of water for 10 mins, then draining and weighing the samples (Lee *et al*., 2011). Cooking loss analysis was carried out by boiling 5 g of the sample in 60 mL of water for 10 mins. The boiled water was then dried in an oven at 105°C and weighed until it reached a constant weight (Ho and Che Dahri, 2016; Kang *et al*., 2017). The cooking loss and water absorption were determined using the following formulae:

$$\text{Cooking loss (\%)} = \frac{\text{weight of dried solid (g)}}{\text{weight of initial sample (g)}} \times 100\%$$

$$\text{Water absorption (\%)} = \frac{\text{weight of noodle after cooking} - \text{weight of noodle before cooking}}{\text{weight of noodle before cooking}} \times 100\%$$

The wet noodles' sensory characteristics were determined by performing an organoleptic test, which included scoring and hedonic. Forty untrained panellists from Universitas Pelita Harapan aged 17-21 participated in the scoring and hedonic test. The resulting wet noodles were boiled in water for 5 mins before sensory analysis.

The hedonic test aimed to determine the degree of acceptance from panellists, including colour, chewiness, stickiness, foreign aroma, foreign taste, and overall acceptance of wet noodles. The scale for the hedonic test ranged from 1 (extremely dislike) to 7 (extremely like).

Meanwhile, the scoring test intended to determine the intensity level of colour, chewiness, stickiness, foreign aroma, and foreign taste of wet noodles. The numerical scale ranges from 1 (the most intense level) to 6 (the least intense level) (Meilgaard *et al*., 2015). The preferred formulation of wet noodles underwent moisture, ash, and texture analyses. Hardness, adhesiveness, and springiness were the texture attributes to be analysed using a texture analyser.

2.2.3 Data analysis

The data were analysed by SPSS version 16 which includes one-way analysis of variance (ANOVA) and Duncan post hoc test.

3. Results and discussion

3.1 Characteristics of marigold flower and marigold powder

Putra *et al*. (2019) produced MP with moisture content ranging from 12 to 17%. This value is lower than the moisture content of the MP produced in this study (7.51±0.09%). The difference in moisture content value is due to differences in drying times even though the temperature and drying equipment used are the same, at 50°C using an oven. However, Table 2 shows the reduction of the moisture content of MF (85.71±0.21%) to MP (7.51±0.09%), indicating that oven drying can reduce the moisture content of MF.

MF and MP have °Hue values in the range of 54°-90°, with a yellow-red colour (Caivano and Buera, 2012). The carotenoids in MF are naturally red, yellow, or orange pigments. The °Hue of the MP can be in the yellow-red colour range (Putra *et al*., 2019). Table 2 also shows that MF (62.90±0.12) have a higher lightness than the powder (52.39±0.09) - this result indicates that the drying process can reduce the brightness level of the MF. According to Putra *et al*. (2019), the lightness of marigold extract ranged from 39.53 to 43.91, where the lightness value was lower than the lightness value of MP produced in this study. The lightness difference may be due to the pre-treatment done by Putra *et al*. (2019). The flower was soaked in lactic acid before drying so that the carotenoid levels were maintained, making the marigold extract darker, thus resulting in a lower lightness value.

Table 2. Characteristics of MF and MP.

Components	MF	MP
Yield (%)	N/A	18.85±0.37
Moisture content (%)	85.71±0.21	7.51±0.09
Lightness	62.90±0.12	52.39±0.09
°Hue	77.28±0.05	72.77±0.05
Carotenoid content (%)	4.40±0.00	6.33±0.39

Values are presented as mean±SD.

Based on Table 2, the carotenoid content of MP was higher (6.33±0.39%) than the fresh marigold's carotenoid content (4.4±0.00%). The drying process can evaporate the water in the ingredients so that the active components of the ingredients, in this case, are more concentrated carotenoids. Thus, the levels of carotenoids produced

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will also be higher in the powdered form.

3.2 The effect of different formulations on the total carotenoid content of wet noodles

Figure 1 shows that increasing powder concentrations added in the wet noodles formulations proportionally correlated with the increase of carotenoid content. The difference in the total carotenoid content between formulations of wet noodles was statistically significant ($p<0.05$), as shown in Figure 1. The carotenoid content of WN5 was significantly the highest (1.91±0.03) compared to other formulations. This result is in line with de Carvalho *et al*. (2012), where the increasing concentration of pumpkin flour added, the β-carotene levels also increased.

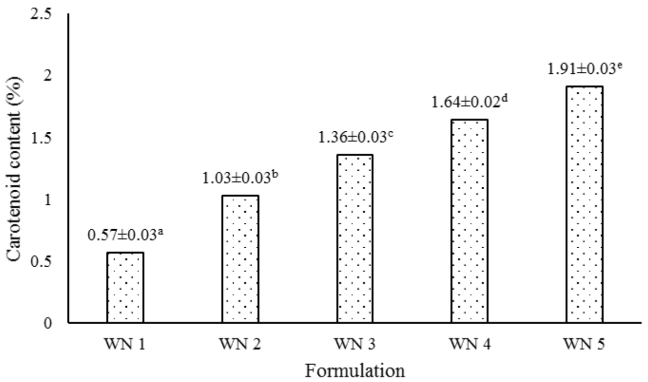

Figure 1. Carotenoid content of wet noodles from different formulations. Values are presented as mean±SD. Bars with different superscript notations indicate significant difference ($p<0.05$). WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

3.3 The effect of different formulations on the cooking loss and water absorption of wet noodles

The cooking loss analysis aims to determine the amounts of dissolved solids from the noodles during the cooking process. It caused the cooking water to become cloudier and thicker; thus, the noodles to break more easily. The lower the cooking loss value of a noodle indicated, the better the cooking quality (Shin *et al*., 2014).

Water absorption aims to determine the ability of noodles to absorb water during the boiling process, which also aims to increase gluten formation. The higher the water absorption value, the more water is absorbed by the noodles and makes the noodles expand (Lee *et al*., 2011; Yu *et al*., 2020). The statistical analysis results showed no significant difference ($p>0.05$) between the different formulations on the cooking loss and water absorption of wet noodles, as shown in Table 3. These results indicated that adding different concentrations of MP did not affect the cooking loss and water absorption of wet noodles. The study conducted by Lee *et al*. (2012) showed a similar result, in which the addition of pumpkin flour does not affect the water absorption value of wet noodles.

Table 3 shows that the value of cooking loss and water absorption was proportionally correlated; the value of water absorption increases with increasing cooking loss. However, the increase in cooking loss and water absorption did not occur significantly. Norlaili *et al*. (2014) reported that the cooking loss of wet noodles added with marigold extract had increased significantly along with the increase of marigold extract addition, which ranged from 2.93±0.06-4.30±0.20%. The cooking loss value of the noodles produced by Norlaili *et al*. (2014) is also higher than the cooking loss value in this study which ranges between 1.00±0.13%-1.08±0.05%. The difference in the cooking loss is due to the concentration of an added MP. Norlaili *et al*. (2014) used 2%, 4%, and 6% of extract concentrations, while in this study, the concentrations of MP used were relatively low, 0.25%; 0.5%; 0.75%; and 1%. This study's lower value of cooking loss indicates the good cooking quality of wet noodles because of the low solid's amount dissolved in the water (Hou, 2010).

Table 3. Cooking loss of wet noodles from different formulations.

Formulations	Cooking loss (%)	Water absorption (%)
WN1	1.00±0.13	87.8±8.73
WN2	1.02±0.12	89.97±6.04
WN3	1.05±0.06	91.60±4.97
WN4	1.06±0.06	90.16±5.67
WN5	1.08±0.05	92.95±10.70

Values are presented as mean±SD. WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

The amylose content of the ingredient used would influence the value of cooking loss and water absorption of noodles. In wet noodle making, the main ingredient used is wheat flour. Wheat flour has a reasonably high amylose content of 25%. The higher the amylose content in the material, the stronger the gel structure formed to produce wet noodles with a reasonably low cooking loss value and a high-water absorption value (Lee *et al*., 2011; Yu *et al*., 2020).

3.4 The effect of different formulations on the lightness of wet noodles

Figure 2 shows a significant difference ($p<0.05$) between wet noodles' formulations on the lightness of wet noodles. The lightness value of WN1 was significantly higher (67.52±2.38) among the other formulations. The addition of MP into wet noodles indicated a decrease in the lightness value. MP has a

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lower lightness value (Table 2), thus affecting its application to the product. Siriamornpun *et al*. (2012) showed that the lightness changes of dried marigolds were lesser for FIR-HA (far-infrared radiation-hot air) than after freeze-drying and hot-air drying. The MF in this study underwent oven drying, which included a hot-air drying process. Thus, the decrease in the lightness level of the resulting powder obtained in this study also follows the result obtained from Siriamornpun *et al*. (2012). Moreover, Raja *et al*. (2019) showed that oven-dried *Carica papaya* leaf powder resulted in the least lightness compared to shade-drying and freeze-drying methods. Thus, it showed that oven drying could reduce the lightness of the resulting powder.

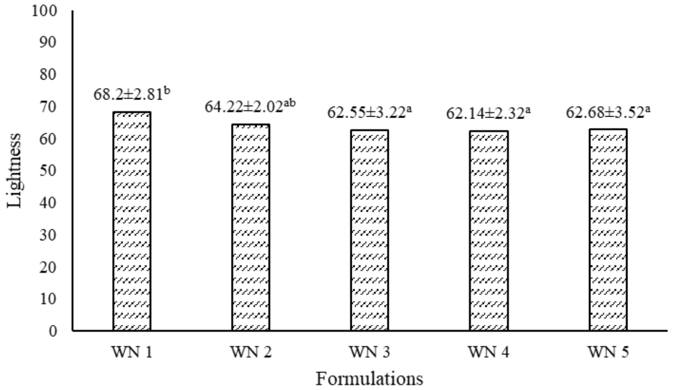

Figure 2. Lightness of wet noodles from different formulations. Values are presented as mean±SD. Bars with different superscript notations indicate significant difference (p<0.05). WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

3.5 The effect of different formulations on the sensory characteristics of wet noodles

3.5.1 Colour

The statistical analysis results showed a significant difference (p<0.05) in colour-scoring values for all wet noodle formulations, as shown in Figure 3. The WN1 was wet noodles with the least yellow colour (5.74±0.44), while the WN5 was wet noodles with a more intense yellow colour (1.11±0.32). A higher concentration of MP will make the wet noodles' colour look even more yellow. The same thing also happened in the research conducted by Toliba *et al*. (2018). The resulting biscuits will have an increasingly yellow colour with an increasing concentration of marigold extract added to biscuits. However, from Figure 3, WN3 has a lesser yellow colour than WN2. The value of cooking loss in WN3 is higher than that of WN2, causing the loss of the yellow colour in WN3 to be more significant. Thus, the panellists also assessed that WN3 is also less yellow than WN2 even though the concentration in WN3 is higher than WN2.

The statistical analysis results showed a significant difference (p<0.05) in wet noodles' colour's hedonic value, as shown in Figure 4. Figure 4 shows that the panellists tend to have neutral to slightly like acceptance of WN3's colour (4.74±1.31). According to Lee *et al*. (2013), panellists prefer brighter food colours than dark colours. In contrast, the panellists tend to slightly dislike the colour of WN4 (3.91±1.14) and WN5 (3.91±1.09). These results show that adding MP above 0.5% produces wet noodles with a more intense yellow colour (Figure 3), reducing the panellist acceptance.

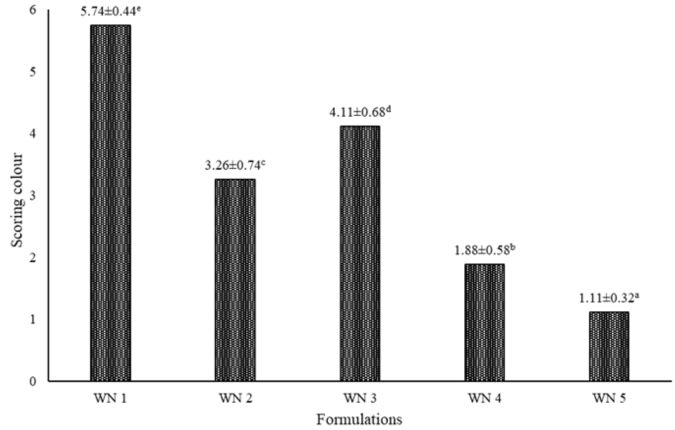

Figure 3. Scoring value for colour of wet noodles from different formulations. Values are presented as mean±SD. Bars with different superscript notations indicate significant difference (p<0.05). WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

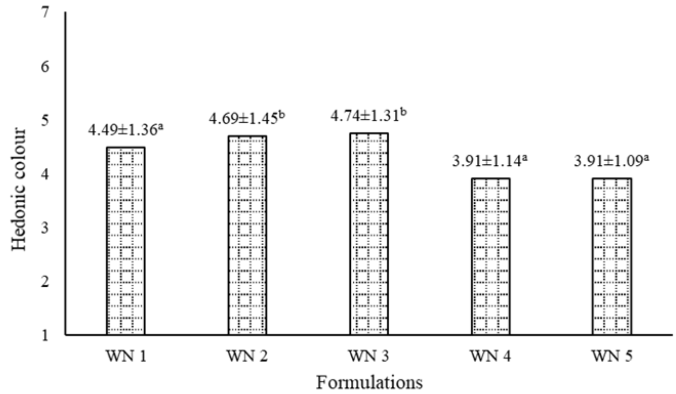

Figure 4. Hedonic value for colour of wet noodles from different formulations. Values are presented as mean±SD. Bars with different superscript notations indicate significant difference (p<0.05). WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

3.5.2 Foreign aroma

The addition of MP at various concentrations showed a significant difference (p < 0.05) in the scoring and hedonic scores for the foreign aroma of wet noodles. The lower score indicates the most intense foreign aroma, and the higher score indicates the least intense foreign aroma. WN1 has a significantly higher score (4.91±1.27) compared to WN3 (4.34±1.21) and WN5 (3.97±1.17), as displayed in Figure 5. These results show that the wet noodles produced have a more intense foreign aroma with an increasing concentration of MP.

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The MF has a distinctive aroma; thus, the resulting powder also shows similar characteristics. The higher the powder added to the wet noodle mixture, the more intense the foreign aroma detected by the panellists, which indicated the presence of foreign aroma in the wet noodle.

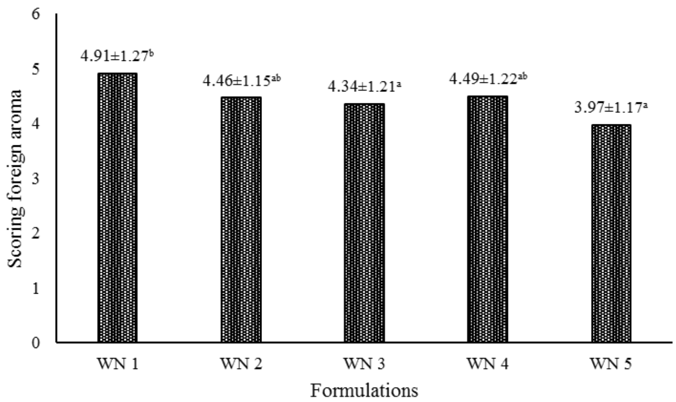

Figure 5. Scoring value for foreign aroma of wet noodles from different formulations. Values are presented as mean±SD. Bars with different superscript notations indicate significant difference ($p<0.05$). WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

Figure 6 shows that WN5 has the lowest hedonic value (4.23±0.97) compared to other formulations. This value indicates that the panellists have a neutral acceptance of wet noodles. This result is supported by the scoring test results (Figure 5), in which WN5 has the lowest score (3.97±1.17) which indicates the most foreign smell. However, the acceptance of panellists toward the foreign aroma of WN1 (4.74±1.09), WN2 (4.94±1.1) and WN3 (4.91±0.89) did not show any significant difference. These results show that adding MP above 0.5% into wet noodles increasingly produces a foreign aroma that the panellists disliked. It is due to the distinctive foreign aroma of marigold, which is getting stronger.

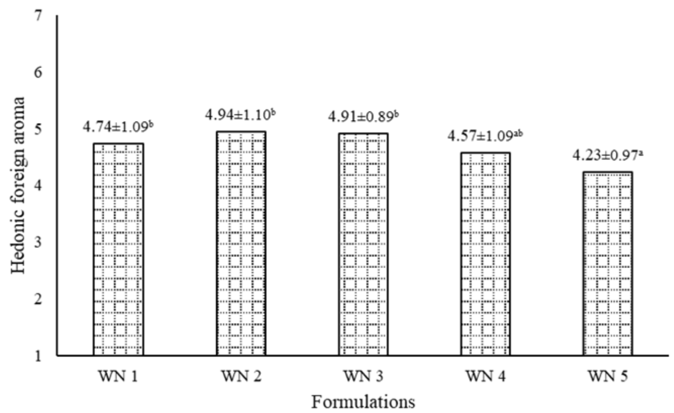

Figure 6. Hedonic value for hedonic foreign aroma of wet noodles from different formulations. Values are presented as mean±SD. Bars with different superscript notations indicate significant difference ($p<0.05$). WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

3.5.3 Foreign taste

The statistical result analysis showed that there were significant differences ($p<0.05$) in the wet noodles formulations on the scoring foreign aroma of wet noodles (Figure 7). However, the different formulations did not show a significant difference ($p>0.05$) in the panellists' acceptance of the foreign taste of wet noodles (Table 4). As displayed in Figure 7, the WN5 had a significantly lowest scoring value compared to other formulations, while the WN1-WN4 formulations are not significantly different. Those results show that the panellists began to detect a foreign taste (4.54±1.14) in the WN5, where the addition of MP reached 1%. Meanwhile, at a concentration lower than 1%, the panellists did not detect any foreign taste in the wet noodles.

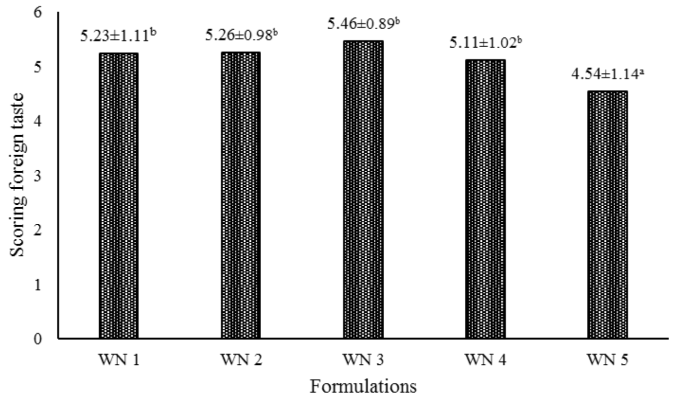

Figure 7. Scoring value for foreign taste of wet noodles from different formulations. Values are presented as mean±SD. Bars with different superscript notations indicate significant difference ($p<0.05$). WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

Table 4 shows that the hedonic value for foreign taste on all wet noodles formulations is within the range of 4.94±1.35 to 5.49± 1.00, which indicates that the panellists have a neutral to slightly like the foreign taste of wet noodles. These results supported the scoring test results (Figure 7), where WN2-WN4 did not significantly differ, meaning that those formulations' foreign taste was of the same intensity as WN1. Even though from Figure 7, WN5 has a more foreign taste, the panellists slightly liked the presence of this foreign taste.

Table 4. Hedonic value for foreign taste of wet noodles from different formulations.

Formulations	Hedonic value of foreign taste
WN 1	4.94±1.35
WN 2	5.49±1.00
WN 3	5.37±0.91
WN 4	5.06±1.03
WN 5	5.06±1.23

Values are presented as mean±SD. WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

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3.5.4 Stickiness and chewiness

Chewiness and stickiness are texture attributes that panellists will assess on all wet noodle formulations. Tables 5 and 6 show the scoring and hedonic values for the chewiness and stickiness attributes, respectively. The statistical results showed no significant difference ($p>0.05$) in all formulations on the chewiness and stickiness of wet noodles. In addition, the panellists' acceptance of the chewiness and stickiness of wet noodles was also not significantly different ($p>0.05$) in all formulations. Table 5 shows that all formulations of wet noodles have a chewy texture. It shows that the addition of MP at any concentration did not affect the chewiness of the wet noodles. The panellists slightly liked the chewy texture of the wet noodles within the value of 5.11±1.32 to 5.51±0.95.

Table 5. Scoring and hedonic value for chewiness of wet noodles from different formulations.

Formulations	Scoring value for chewiness	Hedonic value for chewiness
WN1	3.09±0.82	5.11±1.32
WN2	3.40±1.01	5.40±0.85
WN3	3.46±1.01	5.51±0.95
WN4	3.31±0.76	5.40±0.81
WN5	3.48±1.01	5.20±1.08

Values are presented as mean±SD. WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

Table 6. Scoring and hedonic value for stickiness of wet noodles from different formulations.

Formulations	Scoring value for chewiness	Hedonic value for chewiness
WN1	3.77±1.11	4.94±1.41
WN2	4.11±1.05	5.46±0.85
WN3	4.26±1.17	5.46±1.06
WN4	3.98±1.12	5.06±1.16
WN5	4.03±1.01	5.14±1.19

Values are presented as mean±SD. WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

Gluten is the main factor that generally contributes to the chewy texture of noodles. The gluten matrix can make the bonds between starch granules tighter so that the starch gel is more robust and resistant to the forces and produces a chewier noodle texture (Han *et al*., 2020). In this study, the amount of wheat flour used in all formulations was the same. Thus, it would not affect the chewiness's intensity and the degree of preference of the panellists on the chewiness of wet noodles.

Table 6 shows the score of stickiness in the range of 3.77±1.11-4.26±1.17. Values in this range indicate that the panellists judged all formulations of wet noodles to have a slightly sticky texture. According to Abidin and Devi (2013), the amount of water used strongly influenced the stickiness of noodles. The gelatinization process will be incomplete if the water used is insufficient. It will produce gelatinized starch in a limited amount. Thus, the dough cannot bind properly. However, if the water used is too much, the dough will overcook, which will cause the noodle strands to be stickier due to the large solids' amount diffusing out of the starch. In this study, the amount of water used for all formulations was the same; remarkably, it might not affect the stickiness of wet noodles.

The panellists tend to accept the wet noodle's stickiness within the range of neutral (4.94±1.41) to slightly like (5.46±0.85). It shows that the addition of MP did not affect the stickiness of the wet noodles. The use of salt or alkaline salt has more effect on the stickiness of wet noodles. However, in this study, no alkaline salt was used. In addition, the amount of salt used in all formulations is also in the same concentration. Generally, panellists like noodles that are not sticky or clumped with other noodle strands, not sticky noodles when picked up with chopsticks, and noodles that are not sticky when chewed (Hou, 2010).

3.5.5 Overall acceptance

There was a significant difference ($p<0.05$) in the overall acceptance of wet noodles formulations. Figure 8 displays that the panellists had a neutral acceptance of WN1 (4.94±1.28), then the panellists' acceptance increased to slightly like (5.46±0.85) on the WN3. However, there was a significant decrease to 4.64±1.00 on the WN5. The hedonic value decreased when the MP was added two times higher from 0.5% (WN3) to 1% (WN5). The result of overall acceptance follows Figure 5 and Figure 7, where WN5 has the highest foreign aroma and foreign taste compared to other formulations; thus, the panellists gave a neutral acceptance of the overall WN5.

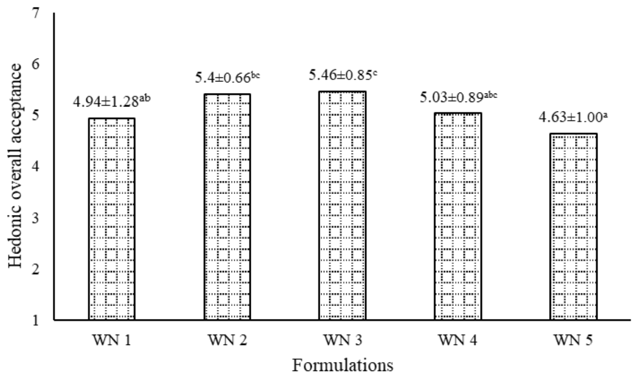

Figure 8. Hedonic value for overall acceptance of wet noodles from different formulations. Values are presented as mean±SD. Bars with different superscript notations indicate significant difference ($p<0.05$). WN1: 0% MP; WN2: 0.25% MP; WN3: 0.5% MP, WN4: 0.75% MP; WN5: 1% MP.

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3.6 Characteristics of the best formulation

The formulation chosen in this study was WN 3. Moisture, ash, and texture were analysed on this formulation, as displayed in Table 7. Hardness, adhesiveness, and springiness were the textural attributes measured on WN3. Based on Table 7, WN3 had a slightly tough texture. Adhesiveness is the power required to attract food from its surface (Miyaoka *et al*., 2013; Mudgil *et al*., 2016). The adhesiveness value of WN3 is relatively low, indicating that the noodles have a sticky texture. The scoring result in Table 6 supported this result, where noodles with the selected formulation have a slightly sticky texture.

Table 7. Result from chemical and physical analyses of WN3.

Analysis	Parameters	Value
Chemical	Moisture content (%)	60.97±0.66
	Ash content (%)	0.41±0.12
Physical	Hardness (gf)	9947.84 ±287.74
	Adhesiveness (g.s)	-2892.55±202.18
	Springiness	0.79±0.02

Values are presented as mean±SD.

Springiness is the height that food can reach between the first and second bites. The springiness value describes the product's ability to return to its initial position after the first compression until the second compression begins (Miyaoka *et al*., 2013; Mudgil *et al*., 2016). Based on Table 7, the springiness value of WN3 is 0.79±0.02. According to Norlaili *et al*. (2014), the springiness value of wet noodles with the addition of *Cosmos caudatus* powder extract ranged from 0.970 to 0.976, where this value was higher than the springiness value of WN3. The difference in the result is due to the use of *kansui* (alkaline salt) by Norlaili *et al*. (2014). *Kansui* is known to increase the elasticity and flexibility of noodles. Moreover, it can increase the smoothness of noodles. Meanwhile, in this study, *kansui* was not used, so it might also affect the springiness value of the wet noodles produced.

4. Conclusion

WN3 with 0.5% MP was selected as the preferred formulation to make wet noodles. The drying process reduced the lightness level of the resulting marigold powder, thus impacting the reduced lightness level of the wet noodles. Therefore, it is necessary to do pre-treatment before the drying process, such as blanching. This pre-treatment is promising in terms of pigment stability.

Conflict of interest

The authors declare no conflict of interest.

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