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PHYSICOCHEMICAL PROPERTIES OF INSTANT PUMPKIN JAVANESE NOODLE GRAVY

[*Sifat Fisikokimia Saus Bubuk Mi Jawa Instan dari Labu Kering*]

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ABSTRACT

This research was carried out to study the physical and chemical characteristics of pumpkin Javanese noodle gravy prepared in powder form. The finished product is categorized as an instant product as it only needs to be rehydrated with warm water (60°C) before consumption. Five gravy formulations were developed with the incorporation of two types of flour (tapioca and corn flours) as the thickening agent. Physical characteristics including colour and swelling properties of the final products were evaluated. For chemical analysis, ash, moisture, protein, crude fiber, fat and carbohydrate compositions were also determined. For physical analysis, all formulations showed similar colour appearance of the gravy powder including lightness (L), redness (a*) and yellowness (b*). Pertaining swelling properties of the dried gravy, the water absorption index (WAI) values were low (2.0–3.0g/g), while the water solubility index (WSI) were moderate (33.0–50.0%) when evaluated at both hot (85°C) and cold (25°C) water. In termn of chemical compositions, carbohydrate and fat content increased and decreased, respectively with the addition of tapioca and corn flours. The moisture content of the instant gravy increased with the increased of corn flour addition. There were differences in fiber and ash content in all formulations, but no specific trend was observed. Finally, protein content remained the same in all formulations. This current finding provided information of the gravy powder produced. Further analysis on the characteristics of the rehydrated pumpkin Javanese noodle gravy will provide a more complete picture of the finished product.

Keywords: corn, gravy, instant starch, pumpkin, swelling, tapioca

ABSTRAK

Penelitian ini dilakukan untuk mempelajari sifat fisik dan kimia saus mi Jawa dari labu kuning berbentuk bubuk. Produk ini tergolong produk instan yang hanya membutuhkan pelarutan dengan air panas (60°C) sebelum dikonsumsi. Lima formula saus dikembangkan menggunakan dua jenis tepung (tapioka dan tepung jagung) sebagai pengental. Karakteristik fisik yang diuji adalah warna dan sifat pengembangan produk akhir. Selain itu juga dilakukan analisis kimia yang meliputi kadar abu, kadar air, serat kasar, lemak dan komposisi karbohidrat. Hasil analisis fisik menunjukkan semua formulasi saus mempunyai kesamaan warna, yang mencakup kecerahan (L), kemerahan (a) dan kekuningan (b*). Sifat pengembangan* (swelling) *saus yang dikeringkan mempunyai indeks absorpsi air* (water absorption index (WAI) *yang rendah (2,0–3,0g/g), dan indeks kelarutan dalam air* (water solubility index (WSI) *yang sedang (33,0–50,0%), jika diuji menggunakan air panas (85°C) maupun air dingin (25°C). Komposisi kimia saus menunjukkan bahwa kandungan karbohidrat meningkat dan kandungan lemak menurun, jika ditambahkan tepung tapioka dan tepung jagung. Kadar air saus instant meningkat dengan meningkatnya jumlah tepung jagung yang ditambahkan. Pada semua formulasi ditemukan perbedaan kandungan serat dan abu, tetapi tidak ditemukan tren yang spesifik, sedangkan kandungan protein relatif sama. Temuan pada penelitian ini memberikan informasi tentang produk saus bubuk. Analisis lebih lanjut tentang karakteristik saus mi Jawa dari labu kuning yang direhidarsi akan memberikan gambaran yang lebih lengkap terhadap produk akhir.*

Kata kunci*: jagung, saus, tepung instan, labu kuning, pengembangan, tapioka*

INTRODUCTION

Pumpkin is one of the tropics' vegetables. Pumpkin is a member of *Cucurbitaceae* family, which includes squash, cantaloupes, cucumbers, watermelons and gourds. It is originated from America. Its shape, size and appearance are different depending on the species (Goncalves *et al*., 2007).

According to the estimation from Agriculture Department from Ministry of Agriculture and Agro-based Industry Malaysia (MOA), the production of pumpkins in year 2010 was 21.1 ton matrices. The production of pumpkins has increased from year 2008 until recent years due to the high demand in local market (MOA, 2012). Pumpkin is eaten as vegetable and cultivated for its young shoots, fleshy, edible flower for its fruits. It contains high nutritional value such as carotenoids, vitamin C, potassium, vitamin E and B (USDA, 2012).

Javanese noodle, also known as *Mi Jawa* is a Nyonya-inspired noodle-soup meal. It is popular dish among Malaysian and Singaporean. It is a noodles dish served with thick sweet potato gravy and garnished with prawns, fried tofu, hard-boiled egg, bean sprout and cucumber. Basically, the gravy is made from sweet potato, curry powder, salted soybeans, dried shrimp, peanut and water. In this modern life, instant foods are very

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popular. Instant foods are convenience foods that need very small effort to cook before consumption (Shittu and Lawal, 2007). For example, multigrain contains mixture of different whole grains to maximize the nutritional values, functional and sensory properties. It is also convenience to people due to its fast and easy preparation method, saving cooking time and only requires little cooking skills (Mandge *et al*., 2011).

Based on the research done by Rakcejeva *et al*. (2011), dried pumpkins have been applied in the production of wheat bread. The carotenoid content increased by 5.5 times comparing to the normal wheat bread. However, there is little or no report exists on the application of starch and pumpkin in the production of Javanese noodle gravy in powder form. This research was carried out to study the physical and chemical characteristics of pumpkin Javanese noodle gravy prepared in powder form with incorporation of corn and tapioca flours.

MATERIALS AND METHODS

Materials

The raw materials used in this research included pumpkin, tomato puree, chilies, spices such as shallots, garlic, ginger and lemon grass, chicken stock powder, cooking oil, salt, corn flour (C) and tapioca flour (T). The type of pumpkin used was *Cucurbita maxima*. All the materials used were purchased from local market in Kuala Terengganu, Malaysia.

Preparation of raw ingredients

The pumpkin was washed and cleaned with potable water. The peel and seeds of the pumpkin were removed. The pumpkins were then cut into small cubes with the size of 2 cm X 1 cm X 0.5 cm and steamed for 15 minutes. The steamed pumpkin cubes were then blended with water at the ratio of 3:1 (w/v). The spices (garlic, shallot, ginger and lemon grass) were cleaned and blended with water at the ratio of 1:1 (w/v). The dried chilies were soaked in hot water until soften and blended with water at the ratio of 1:2 (w/v). The chicken stock powder was dissolved using hot water (34.5 g of powder dissolved in 125 ml of water). The corn flour and tapioca flour were dissolved with water at the ratio of 1:2 (w/v).

Table 1 shows the percentages of corn and tapioca flour added in pumpkin Javanese noodle gravy. The amount of pumpkin puree and all other ingredients were constant except for the flour. The percentages of flour added were based on 3% of pumpkin puree.

Table 1. Formulation of pumpkin Javanese noodle gravy with different percentages of corn and tapioca flour addition

Formulation	Corn Flour (%)	Tapioca Flour (%)
A (Control)	0	0
B	0	100
C	25	75
D	50	50
E	75	25
F	100	0

Preparation of pumpkin Javanese noodle gravy

The blended spices were sautéed for 5 minutes. Chilies paste was then added followed by the chicken stock powder and salts. Lastly, pumpkin puree and tomato puree were added and cooked for 20 minutes. The gravy was stirred occasionally to prevent burning.

Preparation of pumpkin Javanese noodle gravy powder

The cooked gravy was distributed on a tray that covered with aluminum foil. It was dried in a dehydrator (Protech-Lab Dryer, model FSD-380) at 70°C for 24 hours. The dried sample was removed from the aluminum foil and ground by using a blender until fine. The ground sample was sieved using a sieve shaker (Retsch GmbH & Co., model AS200, Germany). Only the samples with the particle size of 500 µm and below were collected. The gravy powder was vacuum packed and stored in the freezer at -20°C for further used.

Physical analysis

Determination of Colour

Colourimeter (Minolta Chroma Meter CR 300, Japan) was used to determine the colour intensity of the samples. The values were indicated as L*, a* and b*. Lightness value (L*) indicates how dark or light the sample is (varying from 0-black to 100-white), a* is a measure of greenness or redness (varying from -60 to +60) and b* is the grade of blueness or yellowness (also varying from -60 to +60). The colourimeter was calibrated against a standard white reference tile prior to the determination process.

Swelling properties of pumpkin Javanese noodle gravy powder

The swelling properties of pumpkin Javanese noodle gravy powder were evaluated by determination of water absorption index (WAI) and water solubility index (WSI) at hot (85°C) and cold (25°C) temperatures. These methods were applied to evaluate the swelling properties of the instant powder when rehydrated in hot and cold condition (Mandge *et al*., 2011; Hamzah and Sandra, 2010).

Determination of water absorption index

Water absorption index (WAI) of the samples was determined by modification of method from Mandge *et al*. (2011) and Hamzah and Sandra (2010). About 0.83 g of sample was suspended in 10 ml of distilled water in a 15 ml centrifuge tube. The contents were mixed gently by inverting twice. The tube was then placed in a water bath with a constant temperature at 85.0±0.5°C and mixed by inverting twice at regular intervals (1 minute for the first 5 minutes and finally 5 minutes for 25 minutes) for a total time of 30 minutes. The tube was cooled rapidly in cold running water and centrifuged at 3000Xg for 15 minutes. The supernatant was poured into a tared evaporating dish and the remaining gel was weighed and calculated as WAI according to equation 1.

$$WAI = \frac{\text{Weight of gel (g)}}{\text{Original weight of dry sample (g)}} \quad \ldots\ldots\ldots\ldots 1$$

Determination of water solubility index

Water solubility index was determined from the amount of dried solids recovered by evaporating the supernatant from WAI test described above. WSI was expressed according to equation 2:

$$WSI = \frac{\text{Weight of dried solid (g)}}{\text{Original weight of dry sample (g)}} \times 100\% \quad \text{.................................2}$$

WAI and WSI were also determined at 25.0±0.5°C.

Chemical analysis

Proximate analysis of pumpkin Javanese noodle gravy powder including moisture content, protein content, fat content, carbohydrate content, ash content and crude fiber content were conducted according to AOAC method (2000).

Determination of moisture content

The moisture content of the sample was determined by using oven-drying method. Initially, the crucible and lid were dried in oven at 105°C for 30 minutes. The crucible and lid were then placed in a desiccator to cool for at least 30 minutes and weighed. About 2 g of sample was weighed and placed in a pre-dried crucible and dried in the oven at 105°C for 24 hours. After drying process, the crucible with sample was transferred into a desiccator for cooling purpose before the weight was measured. The percentage of moisture content was determined according to equation 3 and 4.

$$\text{Percentage of dry matter} = \frac{\text{Weight of dry sample (g)}}{\text{Weight of original sample (g)}} \times 100\% \quad \text{...............3}$$

$$\text{Percentage of moisture content} = 100\% - \text{percentage of dry matter} \quad \text{................4}$$

Determination of protein content

The protein content was determined by Kjeldahl method using Kjeltec System. Approximate 1g of sample was placed into the digestion tube. Two tablet of Kjeltabs Cu 3.5 and 12 ml of concentrated H_2SO_4 were added into the tube while the tube is being slowly shaken to wet the sample. Digestion tube was placed on the rack and exhaust system was connected to the tube. The rack and the exhaust system were placed on the Digested Heater Block D36 at 420°C. The water aspiration was operated to full flow and the digestion was started. It was finished when the green light blue solution formed. The digestion tube was allowed to cool down and 75 ml of distilled water was added. A blank solution was used which also contained only two tablets of Kjeltabs Cu 3.5 and 12 ml of concentrated H_2SO_4 without sample.

The analysis was continued with distillation process with 25 ml of 4% of boric acid and 10 drops of bromocresol green indicator was prepared in a 250 ml conical flask. The digestion tube was placed into the distillation unit (System Kjeltec 2100) and 50 ml of 40% of NaOH was flowed into the tube and the distillation process was done for 4 minutes until the solution turn into light green. The distilled solution was titrated with 0.1 NHCl until the colour turns grey and the titrated volume was recorded. The percentage of nitrogen of protein in the sample was calculated according to equation 5 and 6:

$$\text{Percentage of nitrogen (N)} = \frac{\text{(T-B)} \times \text{N} \times 14.007}{\text{Weight of sample (mg)}} \times 100\% \quad \text{.................5}$$

$$\text{Percentage of protein} = \%\text{N} \times \text{F} \quad \text{...6}$$

Where,
T= volume of titration sample
B=volume of blank titration
N=HCl normality
F=protein factor, 5.7

Determination of fat content

The fat content was determined by Soxhlet method using Soxtec Avanti 2055. Petroleum ether (40-60°C) was used as solvent to extract the fat from sample. Initially, the extraction cup was pre-dried in oven and cooled in desiccators. The pre-dried extraction cup was weighed. Approximate 2 g of dried sample was weighed and placed into the thimble and then placed into extraction unit with thimble handler. Petroleum ether was added into extraction cup for 1 hour extraction process. The ether was evaporated in distiller and the remaining fat was dried in the oven at 105°C for 2 hours. The cup was transferred into desiccators for cooling purpose. Weight of the cup was weighed and the percentage of the fat was calculated according to equation 7:

$$\text{Percentage of crude fat} = \frac{W_3-W_2}{W_1} \times 100\% \quad \text{...7}$$

Where,
W_1= weight of sample (g)
W_2=weight of extraction cup (g)
W_3=weight of extraction cup with fat (g)

Determination of ash content

The ash content was determined by furnace ashing method. The pre-dried crucible was weighed. About 5 g of sample was then weighed and transferred into the crucible. The sample was pre-dried in the oven at 100°C for 6 hours before ashing process. The sample was then ashed by using the muffle furnace at 550°C for about 6 hours and transferred into the desiccators for cooling purpose. The cooled crucible was weighed and the percentage of ash left in the crucible was then calculated according to equation 8:

$$\text{Percentage of ash} = \frac{\text{Final weight of ash (g)}}{\text{Initial weight of sample (g)}} \times 100\% \quad \text{.......................8}$$

Determination of crude fiber content

The crude fiber content was determined by Fiber Cap system using Fibertec 2021. Approximate 2 g of sample was placed into the capsule. Extraction was done by using sulfuric acid and sodium hydroxide. The capsule was dried in the oven and ashing process was performed. The fiber content was then calculated according to equation 9:

$$\text{Percentage of crude fiber} = \frac{W_3(W_1 x C) - (W_5-W_4-D)}{W_2} \times 100\% \quad \text{................9}$$

Where,
W_1= initial capsule weight (g); W_2=weight of sample (g)
W_3=weight of capsule +weight of residue (g); W_4=weight of crucible (g)
W_5=weight of total ash (g); C=error
D=ash of blank capsule (g)

Determination of carbohydrate content

Carbohydrate content was determined by the difference through the use of the following equation 10.

Percentage of carbohydrate =
100%- (% moisture + % ash + % protein+ % fat + % crude fiber) ……………..10

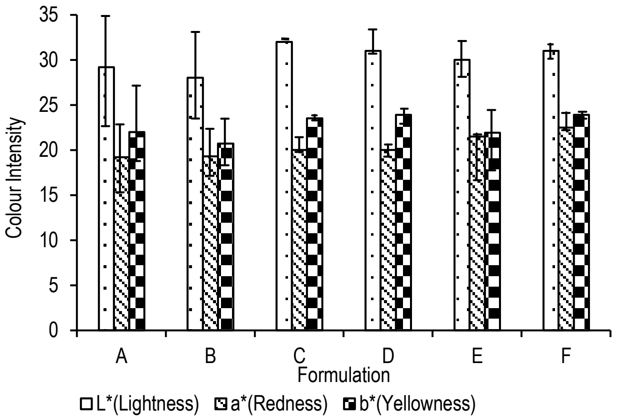
Statistical analysis

All analysis was carried out in duplicates. The data for physical and chemical analysis were subjected to one-way analysis of variance (ANOVA). Results with significant different were further analyzed with post-hoc test using Fisher's LSD test to see differences between formulations of pumpkin Javanese noodle gravy powder. All tests were conducted at 5% significance level and were carried out using Minitab (Version 14) statistical software.

RESULTS AND DISCUSSION

Colour properties of pumpkin Javanese noodle gravy powder

Figure 1 shows the L*, a* and b* values for the colour profile of pumpkin Javanese noodle gravy powder.



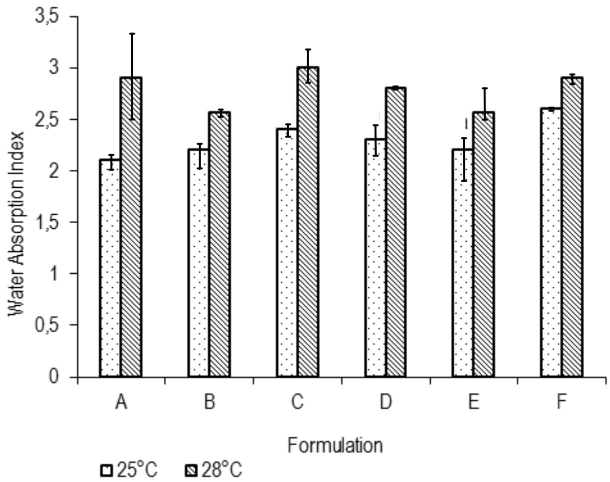
Notes: A (0% C:0% T), B (0% C: 100% T), C(25% C: 75% T), D (50% C: 50% T), E (75% C: 25% T), F (100% C: 0% T)

Figure 1. The colour properties of pumpkin Javanese noodle gravy powder added with different percentages of corn (C) and tapioca (T) flour

There were no significant difference in L*, a* and b* values of all formulations. The addition of different percentages of tapioca and corn flour did not affect the colour properties of the gravy powder. However, it had been observed that the L* values of the dried samples were low when compared to the cooked gravy before drying process (data not shown). This might be due to the browning effect caused by caramelization and Maillard reaction occurred during drying process that contributed to the darker colour of the powder (Caparino *et al*., 2012). Similar findings were also being observed which affected by the drying process of other commodities such as mango powder and strawberry puree (Caparino *et al*., 2012; Abonyi *et al*., 2002). The positive a* and b* values showed as redness and yellowness colour attributes of the noodle gravy powder, respectively. This was due to the presence of carotenoid pigments in pumpkin, which is yellow to red in colour that contributed to the redness and yellowness of the gravy powder (Dias *et al*, 2008). Research done by Pott *et al*. (2005) also found the positive relationship of carotenoid content with the redness characteristics of mango slices when dried at high temperature.

Water absorption index (WAI) and water solubility index (WSI) of the gravy powder

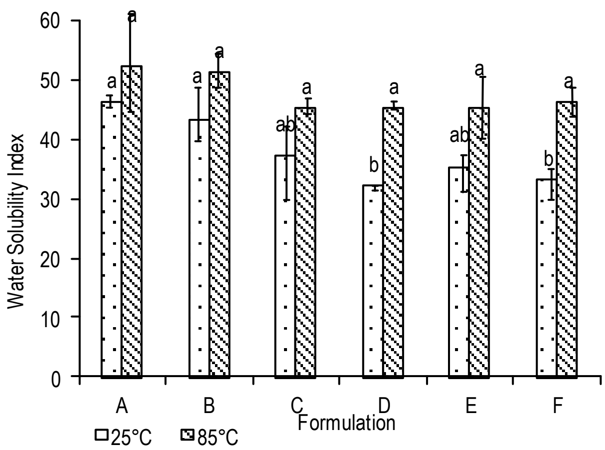
There was no significant difference between all gravy powder formulations for WAI determined at hot (85°C) and cold (25°C) temperatures (Figure 2). It was observed that instant gravy powder had low water absorption index (swelling characteristic) (2.0-3.0 g/g) when compared to the swelling property of native corn and tapioca starches. It has been reported that the swelling property of native corn and tapioca were ranged from 13-20 g/g (Sandhu and Singh, 2007) and 51 g/g (Hoover, 2001), respectively. This was expected as the starch granules in the gravy were already damaged through cooking, hence when dried and rehydrated in excess water, it lost its capacity to hold water, thus reduce their WAI values as compared to their native parts (Sriburi *et al*., 1999).



Notes: A (0% C:0% T), B (0% C: 100%T), C (25% C: 75% T), D (50% C: 50% T), E (75% C: 25% T), F (100% C: 0% T)

Figure 2. Water absorption index (g/g) of pumpkin Javanese noodle gravy powder added with different percentages of corn (C) and tapioca (T) flour determined at cold (25°C) and hot (85°C) temperatures

Water solubility index of all samples were ranged from ~30 to ~50%. The solubility of the gravy powder in excess water (25°C) showed a reduction pattern of the values with the formulation with higher composition of corn flour. However, only formulation C (50% Corn: 50% Tapioca) and E (100% Corn: 0% Tapioca) showed significant difference with the control (Formulation A). In addition, no significant difference of the solubility properties exhibited between all formulations, measured at 85°C (Figure 3). These findings did not show any relationship between water absorptivity (WAI) and the release of soluble starch from the granules (WSI).



Notes: [a-b] means sample with the same letters on the histogram for WSI at 25°C and 85°C are not significant different at p>0.05. A (0% C:0% T), B (0% C: 100%T), C (25% C: 75% T), D (50% C: 50% T), E (75% C: 25% T), F (100% C: 0% T)

Figure 3. Water solubility index (%) of pumpkin Javanese noodle gravy powder added with different percentages of corn (C) and tapioca (T) flour determined at cold (25°C) and hot (85°C) temperatures

In general, through heating and stirring, the starch crystalline structure is broken, the water molecules formed hydrogen bonding with the exposed hydroxyl groups of amylose and amylopectin, thus increased the granule swelling and solubility of the starch constituents (Hoover, 2001; Noranizan *et al*., 2010; Wani *et al*., 2012; Zhou and Lim., 2012). However, according to Sriburi *et al*. (1999), with higher processing levels, the granules damaged make the water easily penetrated into the granules. As the water being absorbed, the granules became highly expanded, thus starch molecules become more soluble and would leave the granules. When this occurred, the WSI (obtained from dried supernatant) will increase and in turn, reduced the WAI (sediment).

Other studies showed that starches have high WSI with the increased of processing temperature (Li and Yeh, 2001; Claver *et al*., 2010). Li and Yeh (2001) found that when WSI was lower than 40%, water absorption properties increased concomitantly with WSI. This meant that, at this level the ability of granules to absorb water is concurrently with the leaching of the starch residue from the swelled granules. Therefore, it had been assumed that the leaching solid did not reduce the water holding capacity of starch molecules and thus, there was no reason to resist the water absorption index.

Chemical properties of pumpkin Javanese noodle gravy powder

Table 2 shows the chemical compositions of pumpkin Javanese noodle gravy powder with the addition of different percentages of corn and tapioca flour. Formulation with 100% of corn flour addition (Formulation F) contained the highest moisture level after drying process and showed significant difference as compared to other formulations (Table 2). This might be due to the low resistant starch composition in corn starch that related to the high water holding capacity of the granules, thus increased the moisture content of the gravy powder (Fuentes-Zaragoza *et al*., 2010). Protein content of pumpkin Javanese noodle gravy powder was similar in all formulations (Table 2). The percentages were low which ranged from 0.6-0.7% as the ingredients used were mostly high in carbohydrates; for example pumpkin, corn and tapioca flour (Guiné *et al*., 2011; USDA, 2012). It has been observed that there was a significant difference in the percentages of fat content in pumpkin Javanese noodle gravy powder with corn and tapioca flour addition. Basically, the addition of corn and tapioca flour reduced the fat composition significantly as compared to the control formulation (0% C: 0% T). Between the formulations, formulation F which was added with 100% of corn flour showed the least fat content and showed significant different with formulation B, C, D and E. It has been expected that the formulation of gravy with higher corn flour addition would contain higher fat composition in final products. This was because corn flour is originally contained higher percentages of lipid (1.22%) as compared to tapioca starch (0.51%) (Mishra and Rai, 2010). However, this research showed opposite finding, where the formulation with the highest composition of corn flour contained the least fat in the final product.

Carbohydrate content of pumpkin Javanese noodle gravy powder increased with the addition of corn and tapioca flour (Table 2). The carbohydrate content for formulations with the addition of corn and tapioca flour was significantly higher as compared to control formulation. This was expected as the flour itself is a source of carbohydrate (Mishra and Rai, 2010). Ash is related to the inorganic residue left after ignition or complete oxidation of organic food stuffs. In this research, the ash content in all formulations was quiet high, which ranged from 9 to 12%. There was significant difference between formulations but no specific trend was observed.

Table 2. Chemical compositions of pumpkin Javanese noodle gravy powder added with different percentages of corn (C) and tapioca (T) flour

Formulation	Chemical Composition (%)					
	Moisture	Protein	Fat	Carbohydrate	Ash	Crude Fiber
A	7.36±0.05[c]	0.75±0.07[a]	26.16±0.91[a]	50.31±1.03[b]	11.62±0.10[a]	3.80±0.11[b]
B	7.62±0.19[c]	0.69±0.07[a]	23.48±0.57[b]	53.95±0.47[a]	10.17±0.31[ab]	4.09±0.05[a]
C	7.98±0.06[bc]	0.67±0.01[a]	23.91±0.17[b]	54.42±0.86[a]	9.66±0.85[b]	3.36±0.10[c]
D	8.21±0.09[b]	0.67±0.03[a]	22.96±0.18[bc]	54.22±0.40[a]	10.78±0.22[ab]	3.16±0.06[c]
E	8.06±0.10[bc]	0.69±0.01[a]	22.62±0.19[bc]	54.80±0.87[a]	10.23±0.57[ab]	3.60±0.01[b]
F	10.58±0.34[a]	0.67±0.02[a]	21.73±0.12[c]	53.02±0.31[a]	9.91±0.18[b]	4.09±0.08[a]

Notes: [a-c] means sample with the same letters within column are not significant different at p>0.05; A (0% C:0% T), B (0% C: 100% T), C (25% C: 75% T), D (50% C: 50% T), E (75% C: 25% T), F (100% C: 0% T)

According to USDA National Nutrient Database (2012), pumpkin contained high amount of minerals and vitamins. This was supported by Guiné *et al*. (2011) who found that dehydrated pumpkin at 70°C has high amount of ash content which also contribute to the amount of ash in final product. There was a significant difference in the percentages of fiber content in the gravy powder. However, no specific trend was observed and this might probably contributed by the spices used in the ingredients such as shallots, garlic, ginger and lemon grass (USDA, 2012).

CONCLUSION

In conclusion, current study showed that different types of flour used had no effect on the appearance and swelling properties of the pumpkin Javanese noodle gravy powder. The addition of flours in the formulations had increased the moisture and carbohydrate content. On the other hand the fat content was reduced. Further analysis including viscosity, rehydration properties and sensory evaluation will be carried out to provide more complete findings of the finished product.

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