Research Article

Effect of Mango Kernel Seed Composite Flour on the Quality of Instant Noodles

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ABSTRACT

Wheat or rice flour is the main ingredient of instant noodles, a well-known staple food in the world, and its global demand is increasing by the day. In this study, mango kernel seed (MKS) composite flour instant noodles were formulated in order to evaluate the effect of MKS flour on the quality of instant noodles. There were two varieties of instant noodles made: air-dried and fried, and they both contained 10, 15, and 20% MKS flour. The physicochemical, sensory, and storage properties of the created composite flour instant noodles were examined. Results was showed that MKS composite flours have higher water absorption, dough development time, and degree of softening compared to wheat flour. Results were also showed that all MKS composite flours yield good starch swelling with the increase in peak viscosity (620–1267 AU), while decreasing in peak viscosity temperature (93–81°C). MKS composite flour instant noodles produced from 15% MKS composite flour and frying method were found to be the best formulation in terms of sensory, TPA, tensile strength, and storage quality. The utilization of 15% MKS composite flour in fried instant noodles was enriched in total dietary fiber (6.40%) and can significantly reduce the energy content of the final product. The product showed it was stable with low moisture content and microbial load in the range of 3.25×10^1 to 3.41×10^2 cfu/g, indicating that the sample was still safe to be consumed. The multiple comparison sensory evaluation throughout six weeks in accelerated conditions also showed no significant difference ($p>0.05$) between fresh and stored samples, indicating higher eating quality stability.

Received: 25 March 2025
Accepted: 28 July 2025
Published: 30 September 2025
DOI: https://10.51200/ijf.v2i2.6262

Keywords: accelerated storage; instant noodle; mango seed kernel; nutrient content; physicochemical properties

1. Introduction

The instant noodles are defined as products prepared from wheat flour or rice flour as the main ingredient, with or without the addition of other ingredients (Codex Alimentarius Commission, 2023). They are characterized by the use of pre-gelatinization and dehydration processes through frying or drying methods. In general, instant noodles are made from wheat flour, starch, water, salt, and alkaline water, which is also called *kansui* by countries in Southeast Asia containing a mixture of sodium carbonate, potassium carbonate, and sodium phosphate (Gulia *et al*., 2014). Instant noodle processing involves mixing the raw materials, dough mixing, dough compression and rolling, steaming and formation of noodles, dehydration of noodles, and finally packaging of instant noodles. Instant noodles are a famous staple food in the world, and their global demand is increasing by the day (Roselina & Muhamad Tauseef, 2015). Likewise, consumer demand for instant noodles is also increasing in Malaysia. Food and Agricultural Organization (FAO, 2024) reported that the estimated sales value of instant noodles in Malaysia increased by 54.3% from 2020 to 2022.

Instant noodles are often regarded as a non-nutritious and high-calorie food because each serving contains a high amount of carbohydrates and fat as well as low amounts of dietary fiber, vitamins, and minerals. In order to produce instant noodles that are rich in nutrients and low in calories, various types of flour made from other raw materials are mixed together with wheat flour as composite flour. For example, Reungmaneepaitoon *et al.* (2009) have developed instant noodles from purple yam composite flour to increase the dietary fiber content and antioxidant activity. In another study, Hou and Jimenez (2012) have also developed instant noodles with barley composite flour to enrich the content of soluble fiber, such as β-glucan which acts to lower cholesterol serum and glucose in blood.

The problem of food waste is also an issue of concern lately. In Malaysia, 50% of solid waste is contributed by food waste (Jereme *et al.,* 2017). Xue *et al.* (2017) found that the fruit by-products have contributed 3.6% of food waste produced in Southeast Asia. Thus, reuse of fruit by-products in food production is important to overcome the issue of food waste management (Jereme *et al.,* 2017). Reuse of fruit by-products is a non-conventional source of food that has caught researchers' attention due to its suitability to meet human nutritional needs at lower costs, especially in developing countries (Aït-Kaddour *et al.,* 2024). One of the interests in the food industry is the creation of food products rich or enriched with dietary fiber, vitamins, and minerals, using common food materials (Haque *et al.,* 2023). Thus, the mango seed is a suitable food raw material to incorporate with instant noodles because mango seed has not been utilized in the production of cheap staple foods such as instant noodles. Mango seeds are a single large seed, oval and surrounded by fibrous endocarp during maturation, and contribute 17 to 22% of the total fruit weight (Beriso & Tesfaye, 2024). It has three parts: hard endocarp, brown seed coat, and white endosperm, which is the kernel. The concept of using mango seed kernel flour in food production had been submitted, and the study of mango seed kernel has just begun using it to show its potential uses (Mas'ud *et al.,* 2020).

The mango kernel seed was transformed into flour and used in the development of instant noodles because it is a source of non-conventional foods, the material side, which has the potential to provide additional value such as bio-active ingredients to a food product at a lower cost (Kabir *et al.,* 2024); furthermore, MS flour also raises the dietary fiber content in food (Guan *et al*., 2024). Therefore, the purpose of utilizing mango seed turned into flour in this study is to produce instant noodles that can be categorized as functional food products and can also provide additional benefits to human health other than the existing nutrients. The aim of this study was to evaluate the effect of MS flour on the quality of instant noodles. Furthermore, the physicochemical, sensory, and storage stability of the formulated MS composite flours were determined.

2. Materials and Methods

2.1 Preparation of mango seed flour

Mango fruits (*Mangifera indica L.)* were collected from local markets in Kota Kinabalu, Sabah, Malaysia. The mango fruit was washed and peeled. Mango pulp was separated from the seed to obtain its endocarps. All endocarps of mango seeds were soaked in distilled water while every endocarp of mangoes was opened with a knife to remove the white seed kernel, which is the endosperm of mango seeds. The seed kernels produced were cleaned by peeling the brown skin coating the kernels. Then, the cleaned seed kernels were cut in cross-section with a thickness of 5.00±0.01 mm and blanched in boiling water for three minutes and then dried in a drying cabinet (Protech, Malaysia) for 18 hours at 50±2°C. The dried mango seed kernels were then milled to flour using a blender (Panasonic, Japan) and sieved through a standard 30 mesh sieve (Hamid *et al.,* 2023).

2.2 Physicochemical tests for MS composite flour

The recovery of mango seed kernel flour was calculated in percentage using the method established by Yatnatti *et al.* (2014). The differences in dough and gluten quality of the composite flour incorporated with 10, 15, and 20% of MS flour as well as the control wheat flour were evaluated using Farinograph (Brabender, Germany). The differences of starch quality and enzyme activity in between the composite flours incorporated with 10% (F1), 15% (F2) and 20% (F3) of MS flour as well as the control wheat flour were evaluated by using Amylograph (Brabender, Germany)(Wang *et al.*, 2022).

2.3 Production of MS composite flour instant noodles

Instant noodles were developed based on different percentages of wheat flour and three different percentages of MS flour, which were 10, 15, and 20%. The liquid mixture was prepared by mixing alkaline salt (*kansui*), salt, and water before they were poured into the mixed flours. The mixing process took about 15 minutes to make sure the ingredients were well mixed and hydrated. The dough was rolled into a dough sheet with the rollers on the noodle-making machine. A thin sheet of dough was folded together and continued rolling to a thinner sheet of dough. The sheeting process was repeated several times until the resulting dough sheet became very thin with a thickness of 0.20 ± 0.01 cm. A thin layer of dough was cut into long strands of noodles with a pair of cutters before undergoing a steaming process at 100 ± 2°C for ten minutes until cooked (Wang *et al.,* 2024). The steamed noodle strands were cut and arranged in circular blocks, which were divided into two groups; one group was dehydrated in a drying cabinet with hot air at 80±2°C for one hour, while another group was fried in hot palm oil at 140±2°C for one minute (Adejunwon *et al.,* 2019). Instant noodles that had been dehydrated with hot air drying and frying methods were left to cool, packaged, and stored in an airtight propylene (PP) plastic bag at room temperature of 25±2°C.

2.4 Sensory evaluation for MS composite flour instant noodles

A hedonic test was conducted to determine the best formulation, respectively, from the fried instant noodles and air-dried instant noodles following the method used by Bhatt and Gupta (2023). A seven-point Likert scale is used to assess the sensory attributes (colour, aroma, taste, texture, and overall acceptance). A paired comparison test was used in order to select the best fried and air-dried instant noodles.

2.5 Physicochemical tests for MS composite instant noodles

Texture Profile Analysis (TPA) was conducted using a texture analyzer (Stable Micro Systems, United Kingdom) according to the settings recommended by El-Sohaimy *et al.* (2020). Another physicochemical test on its tensile strength was conducted using the same texture analyzer. The settings of the texture analyzer were set according to El-Sohaimy *et al.* (2020), whereby the pre-test speed was set at 1.0 mm/s, the test speed was set at 3.0 mm/s, the post-test speed was set at 10.0 mm/s, the strain was set at 70%, the trigger type was in auto mode, and the trigger force was set at 5.0 g. For color measurement of instant noodles, the Hunter L*, a*, and b* calorimeter was used according to the method by Bhatt and Gupta (2023).

2.6 Proximate analysis of the best MS instant noodles formulation

Some of the best instant noodle formulations were selected to represent the sample, where the instant noodles were broken into small pieces manually. Small fragments of instant noodles were then ground into powder using a grinder. Instant noodle samples were stored in an airtight container for triplicate proximate analysis. The same sample preparation procedure was repeated again for control samples of instant noodles made from composite flour without mango seed kernel flour. All proximate composition, which included the moisture content, ash, crude fat, protein, crude fiber, and total carbohydrates, was determined according to AOAC (2010).

2.7 Total dietary fibre and energy content analysis

Total dietary fibre content for the control sample of instant noodles and samples of best instant noodles formulation were determined by AOAC (2010). The energy content of both the samples of best instant noodles formulation and control sample of instant noodles were determined using the following equation 1.

$$Energy\ (kcal) = (C \times 4) + (P \times 4) + (F \times 9) + (D \times 2) \quad (1)$$

Where, C = carbohydrate content (g), P = protein content (g), F = fat content (g), and D = total dietary fibre content (g)

2.8 Accelerated shelf life study

The test was conducted by the accelerated shelf life test model used by Ancheta *et al.* (2020). The best mango seed kernel instant noodles formulation was packed in a 0.10±0.01 mm polypropylene (PP) plastic bag and stored in the storage cabinet (Binder, Germany) at 45±2°C. Quality assessment during the six months of storage at 25±2°C for instant noodles was estimated to be equivalent to six weeks at 45±2°C when the accelerated shelf life test was conducted. During the storage period of instant noodle samples for six weeks, the moisture content analysis (AOAC, 2010), microbiological testing, and paired comparison tests were carried out on a weekly basis. All test results for instant noodle samples that were stored every week were compared with fresh control samples. A microbiological test for total plate count (TPC) and yeast and mold was conducted according to Akhigbemidu *et al.* (2015).

2.9 Statistical analysis

Statistical analysis was performed on all the data collected from proximate analysis, total dietary fiber, physicochemical tests, and sensory evaluation tests using IBM SPSS Statistics Version 20. An independent group t-test was used to analyze the results for proximate analysis, total dietary fiber, energy content, and accelerated shelf life test. Analysis of Variances (ANOVA) and Tukey's test were used to analyze the significant differences between the samples.

3. Results and Discussion

3.1 Farinograph profile of MKS flour

Farinograph profiles of MKS flour are shown in Table 1, showing that the addition of MKS flour into the noodle dough increased the water absorption gradually. The water absorption was significantly affected by the ratios of MKS flour. For example, the percentage of water absorption increased from 59.1% (control) to 60.4% (F1) and 61.2% (F3) with an increase in MS flour from 10% to 20%, respectively. The increasing phenomena observed in this study could be due to the content of starch and dietary fiber present in the MS composite flour that increased the ability of composite flour to bind and hold more water (Ajatta *et al*., 2016; Yatnatti *et al*., 2014). Previous studies (Urigacha, 2020; Maloma *et al.,* 2011) have also shown that dough made from composite flour absorbs more water than the dough made from wheat flour. Therefore, the addition of water to the MKS composite flour must be well controlled to form optimum dough, and the water required may be much less than dough made from wheat flour.

Table 1: Effect of MKS flour incorporation to instant noodles dough in the farinograph parameters.

Flour Samples	WA (%)	AT (min)	DDT (min)	DS (min)	MTI (FU)	DS (FU)
Control	59.1±0.23^{a}	0.9±0.03^{a}	4.8±0.01^{a}	11.8±0.02^{a}	463±6.74^{b}	11±0.13^{c}
F1	60.4±0.55^{a}	0.9±0.03^{a}	5.2±0.01^{a}	7.6±0.01^{ab}	527±9.05^{a}	42±0.93^{b}
F2	60.9±0.86^{a}	0.5±0.02^{b}	5.4±0.02^{a}	6.4±0.01^{b}	455±7.87^{b}	53±1.03^{b}
F3	61.2±0.82^{a}	0.5±0.01^{b}	5.7±0.01^{a}	6.0±0.01^{b}	409±8.83c	70±1.66^{a}

WA: water absorption at 14% moisture; AT: arrival time; DDT: dough development time; DS: dough stability; MTI: mixing tolerance index; DS: degree of softening; FU: Farinograph unit
Values in the same column with different superscript letters are significantly different ($p<0.05$)

Apart from water absorption of composite flour samples, other Farinograph parameters, such as dough development, have been evaluated together with the water absorption to determine whether the quality of the flour is good or bad (Olakanmi *et al*., 2023). Dough development time for composite flour samples F1 (5.2 min), F2 (5.4 min), and F3 (5.7 min) was higher than the control sample (4.8 min). On the other hand, the dough stability of the composite flour samples F1 (7.6 min), F2 (6.4 min), and F3 (6.0 min) was lower than the control sample (11.8 min). For degree of softening, the control sample (11 FU) was lower than the composite flour samples F1 (42 FU), F2 (53 FU), and F3 (70 FU). Among the MS composite flours studied, composite flour F1 was the best flour due to its high water absorption (60.4%), longest dough stability (7.6 min), and the lowest degree of softening (42 FU) compared to other composite flours such as F2 and F3.

Overall, the dough development time showed an increasing trend from the control sample to the composite flour samples F1, F2, and F3, whereas the dough stability showed a downward trend. The findings of this study were consistent with the study conducted by Yang *et al.* (2024), where an increasing trend in the dough development time and a declining trend in the dough stability with the addition of MS flour in the composite flour were reported. According to Yatnatti *et al.* (2014), a decrease in dough stability can be caused by the high fat content of mango seed. Moreover, the protein content in the mango seed is also lower than in wheat flour. Low protein content will affect the formation of gluten in the dough because dough development time depends on the quality of gluten, the size of starch granules, and the degree of starch damage. (Shang *et al.,* 2023) reported that the dilution of gluten protein in flour is contributed by the high fat and low protein contents in MS flour. Therefore, the dough development time of MS composite flour samples will take longer than the control sample. Practically, the flour that has high dough stability and a low degree of softening can last longer in the tedious mechanical process such as dough sheeting during instant noodles processing (Adejunwon *et al*., 2019). Hence, the best flour samples to be handled in the mechanical process of instant noodle manufacturing are the control sample and composite flour sample F1. For composite flour samples F2 and F3, the control of water added and the addition of supplementary material are needed to improve the stability of dough formation for instant noodles (Gulia *et al*., 2014).

3.2 Amylograph profiles of MKS flour

Peak viscosity and peak viscosity temperature are shown in Fig. 1 and Fig. 2. The control sample had the lowest peak viscosity (620 AU) because the damaged starch content in wheat flour is easily attacked by amylase enzyme (Adejunwon *et al*., 2019). Low peak viscosity can also be caused by a complex formed by protein with the starch granule surface that prevented the release of exudates (Li *et al.,* 2022). The study conducted by Tiga *et al.* (2021) has shown that the smoothness of instant noodles is positively correlated with the peak viscosity of flour. Thus, when the texture of mango seed kernel instant noodles is preferred by the panels over control instant noodles, it indicates that a high peak viscosity for MS composite flour can contribute to the smooth texture of instant noodles. Based on Figure 1a, the peak viscosity of composite flour samples increased from 620 AU to 1267 AU when the amount of MS flour substituting wheat flour increased. The increase in peak viscosity can be caused by the maximum swelling of starch granules, and swollen starch will contribute to a more uniform and compact gluten and starch network (Li *et al.,* 2014).

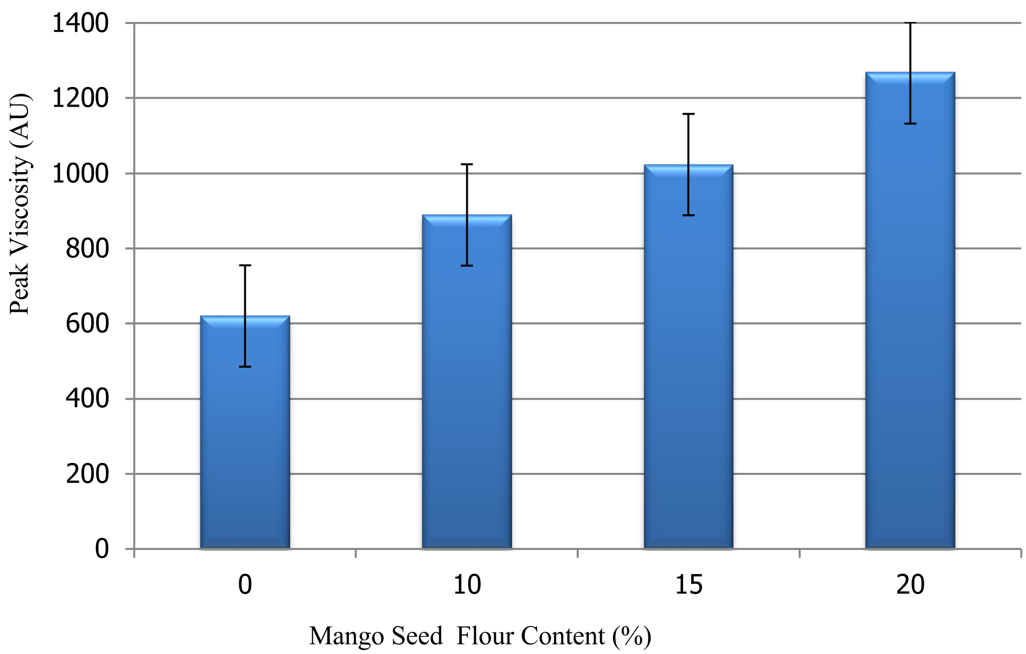

Figure 1: Peak viscosity (AU) and Peak viscosity temperature (°C) for MKS composite flour

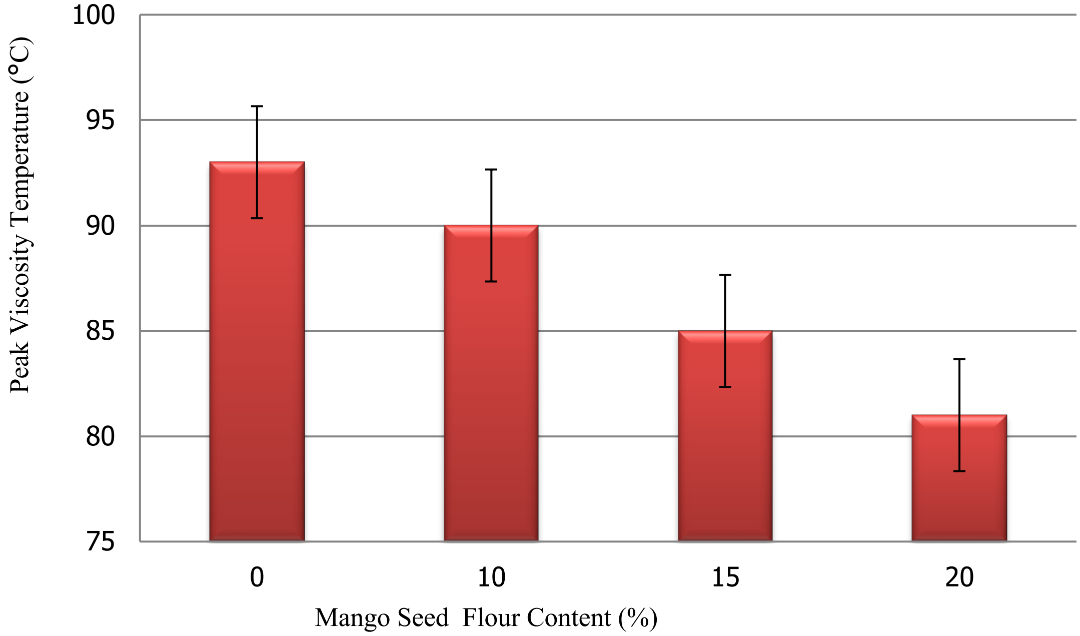

Figure 2: Peak viscosity (AU) and Peak viscosity temperature (°C) for MKS composite flour noodles

Based on Figure 2, the peak viscosity temperature of instant noodles flour declined consistently from 93 to 81°C with the addition of MS flour in composite flour. The fall in peak viscosity temperature of the flour samples can be explained by an increase in starch content as a result of the addition of MKS flour, and an excessive amount of starch is diluting the gluten network (Li *et al.,* 2022; Li *et al.*, 2014). Amylograph provides information about the starch gelatinization properties of MKS composite flour. This information is essential to improve the quality of instant noodles made from composite flour, which lacks gluten, so that the quality is identical to instant noodles made from wheat flour (Li *et al.*, 2014).

A good and satisfying texture of instant noodles does not only depend on flour quality but also the instant noodles processing methods, such as starch gelatinization and dehydration methods, by either frying or drying (Gulia *et al.*, 2014). The frying method improves the incomplete starch gelatinization during the steaming process by further gelatinizing the starch before free water evaporates from the surface of instant noodles (Wang *et al.,* 2021). A perfect gelatinization will contain an optimum amount of swollen starch granules as the binders for wheat gluten and

starch so that the gluten network in the noodles is strengthened (Li *et al.*, 2014). An enhanced degree of gelatinization after frying the steamed noodles will achieve the desired viscoelasticity and solidity even though the MKS composite flour used for instant noodle production is low in wheat protein (Gulia *et al.*, 2014; Li *et al.*, 2014). Hence, the quality of composite flour evaluated based on Farinograph and Amylograph provides information on the physicochemical characteristics of the flour so that the instant noodles processing conditions can be estimated to develop dough that can be worked into instant noodles successfully.

3.3 Best instant noodles formulation made from MKS composite flour

3.3.1 Sensory characteristics of MKS instant noodles

Figure 3 showed the instant noodles produced from different formulations of MKS composite flour. The best formulation of MKS instant noodles was obtained by comparing the formulation chosen by the panel from the respective category of fried and air-dried instant noodles. Overall, the sensory mean scores among the five sensory attributes of fried instant noodles F1 and F2 showed a significant difference ($p<0.05$), whereas the sensory mean score for the fried instant noodle F3 was insignificant. Based on Figure 3, four sensory attributes such as colour, smell, taste, and overall acceptance of fried instant noodles, F2 had the highest sensory mean score as compared to fried instant noodles, F1 and F3. Such a high mean score of colour (5.85), aroma (5.80), flavour (5.93), and overall acceptance (6.30) for fried instant noodle F2 indicated that the incorporation of 15% MKS flour in the composite flour is the optimum amount to improve the color, aroma, and taste of the final fried instant noodles.

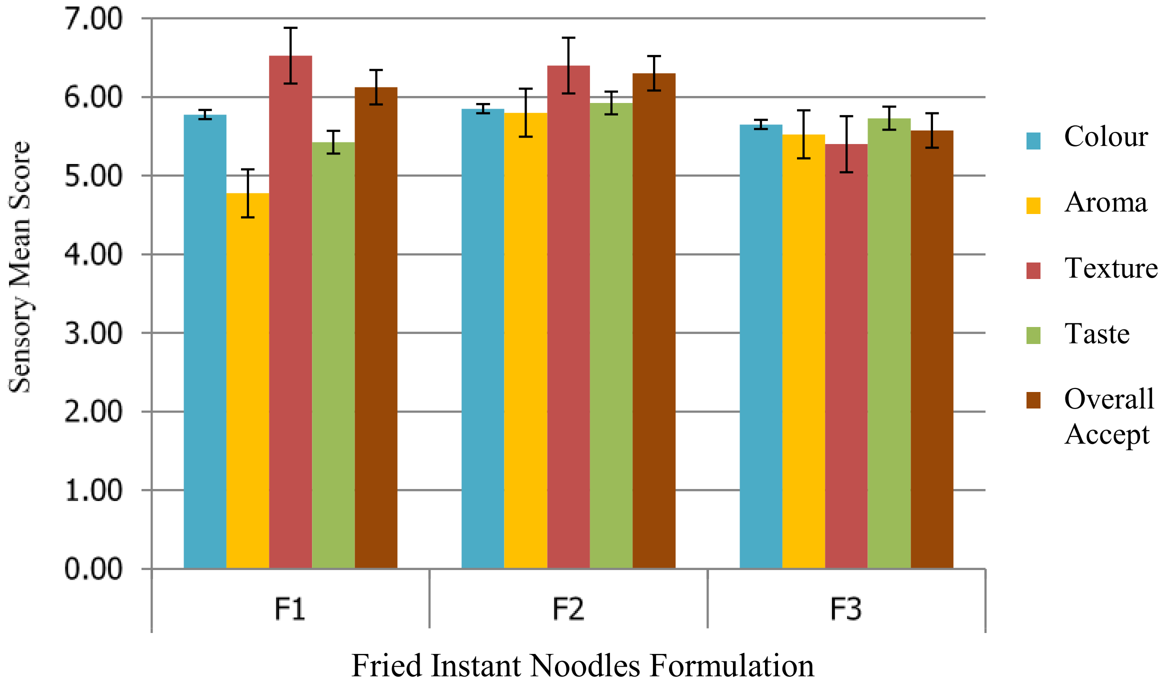

Figure 3: Sensory mean score of fried instant noodles made from MS composite flour formulations

Menon *et al*. (2014) found that when the MKS flour component exceeded 15%, then the content of tannins and polyphenol oxidase in the flour resulted in a darker colour and slightly off flavour in the final product. Similarly, Yu *et al.* (2023) found the same result whereby the acquired mean scores of color and flavour were lower for fried instant noodle F3 due to the higher content of tannin and polyphenol in the formulation (20% MKS flour). Figure 3 indicated that the mean scores for the texture attribute of F2 (5.40) were not significantly different ($p>0.05$) compared to F1 (5.53). This was due to the respective wheat flour component in F1 and F2, which contributed
to the formation of a gluten network that gave the equally favored texture of instant noodles (Gulia *et al*., 2014). However, the mean score for texture of F2 showed no significant difference ($p>0.05$) but a higher mean score for other sensory attributes and selected the best sample for fried treatment.

Figure 4 showed the sensory mean score for all formulations of air-dried instant noodles. The F1 sample showed the significantly ($p<0.05$) highest mean score of all attributes (color, texture, and overall acceptability) with values of 5.30, 5.23, and 4.78, respectively, and selected a sample for air-dried treatment. The sensory mean scores for the two samples of fried instant noodles and air-dried were found to be significantly different from each attribute ($p<0.05$), except for the color, which showed no significant difference ($p>0.05$). Figures 3 and 4 indicated the sample of fried instant noodles earned the highest mean score, followed by the sample of air-dried instant noodles in all sensory attributes that were being studied. This indicated that the fried instant noodle was more favorable and acceptable as compared to the air-dried instant noodles. A previous study by Reungmaneepaitoon *et al.* (2009) also reported a mean score for overall acceptance of instant noodles from composite flour with a range of 5.66 to 6.10. Furthermore, the texture of fried instant noodles was given a mean score of 6.33, and it was more preferred by the panelists compared to that of air-dried instant noodles, which was only given a mean score of 5.00. The 15% MKS composite flour has been used to produce fried instant noodles, and the results of sensory evaluation showed a higher mean score of texture than air-dried instant noodles made from 10% MKS composite flour. This is because the frying instant noodles after steaming stabilized the starch gelatinization process before the free water evaporated from the surface of instant noodles with an optimum amount of swollen starch granules in the instant noodles to act as binders to strengthen the gluten and starch network (Yu *et al.,* 2023; Li *et al.*, 2014). The mean score for the aroma of fried instant noodles (6.03) was higher than that of air-dried instant noodles (4.83) preferred by the panels. This was due to the effect of frying oil, which gave the desired aroma of fried instant noodles (Yu *et al.,* 2023; Bhatt and Gupta, 2023). The high scores on the attributes of aroma, taste, and overall acceptance of fried instant noodles resulted in fried instant noodles as the best.

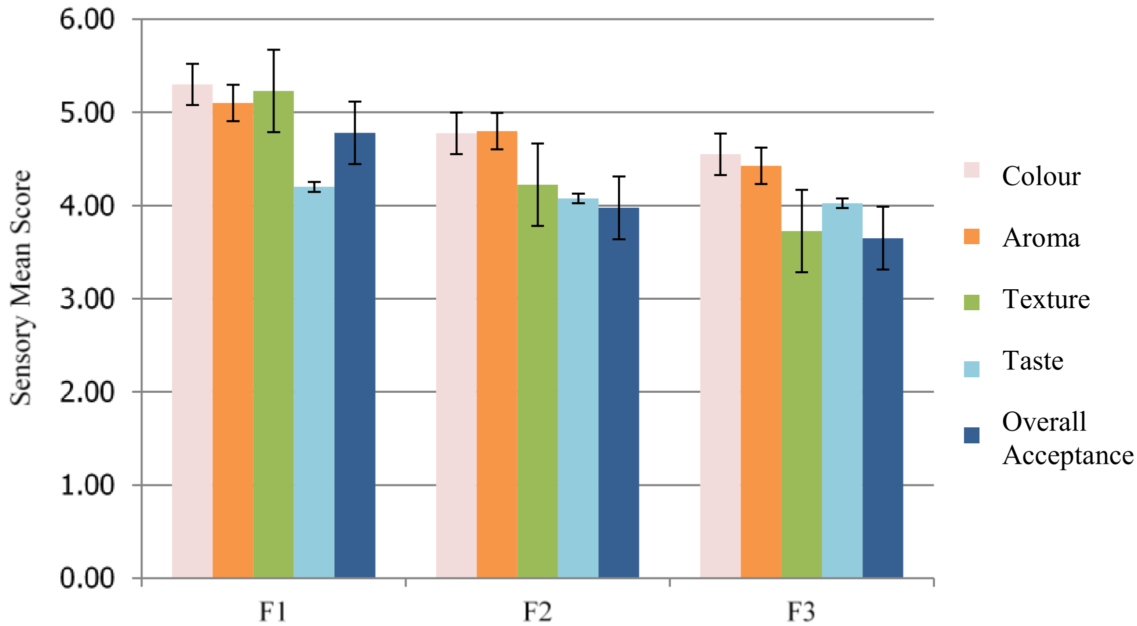

Figure 4: Sensory mean score of air-dried instant noodles made from MS composite flour formulations

3.3.2 Physicochemical characteristics of MKS composite flour instant noodles

Table 2 shows the TPA of fried and air-dried instant noodles. All the TPA parameters showed no significant difference ($p>0.05$) except for adhesiveness, which showed significantly higher ($p<0.05$) for the fried instant noodles. TPA results showed that different methods of dehydration can affect the adhesiveness of the resulting instant noodles, especially the mouthfeel of noodles during consumption (Adejunwon *et al.,* 2019; Gulia *et al.,* 2014). The capability of the frying method to improve the adhesiveness and eating quality of instant noodles made from composite flour high in MS flour (Gulia *et al.,* 2014). Although 15% of MKS flour (F2) has been used to produce fried instant noodles, its adhesiveness value in TPA was still higher than the air-dried instant noodles made from 10% MKS flour (F1). Air-dried instant noodles gave the lowest gumminess and chewiness values. According to Xu *et al.* (2020), the low values of gumminess and chewiness can result in lower texture mean scores (5.00) obtained by air-dried instant. On the other hand, the gumminess and chewiness parameters for fried instant noodles had a higher value than the air-dried instant noodles.

Table 2: Texture profile analysis (TPA) of instant noodles, n=3

Instant Noodles	Hardness (N)	Adhesiveness (N)	Cohesiveness Ratio	Springiness (mm)	Gumminess (N)	Chewiness (N•mm)
Air-dried F1	7.14±1.19[a]	-0.02±0.02[b]	0.70±0.076[a]	1.00±0.00	5.01±0.86[a]	5.01±0.86[a]
Fried F2	6.41±0.34[a]	-0.11±0.06[a]	0.84±0.11[a]	1.00±0.00	5.36±0.91[a]	5.36±0.91[a]

Values in the same column with different superscript letters are significantly different ($p<0.05$)

TPA results in Table 2 showed the tensile strength did not show any significant difference ($p>0.05$) between the two samples to prove that different methods of dehydration can affect the texture of instant noodles as evaluated by the panels. The L* value for air-dried instant noodles is higher than for fried instant noodles, which manifested in its brightness due to dehydration. Whilst the color of fried instant noodles was darker and more yellow than air-dried instant noodles, enhanced as a result of frying in hot oil (Gulia *et al.,* 2014), which was also consistent with the study conducted by Reungmaneepaitoon *et al.* (2009). Therefore, the fried instant noodles were chosen to be further analyzed for their nutrient compositions.

3.4 Nutrient composition of the best MKS composite flour instant noodles

The proximate composition of control and best instant noodle samples was shown in Table 3. The sample was analyzed for its chemical composition as compared to the control sample without mango seed flour. Results for ash content were significantly higher for the best sample (13.38%) compared to control samples (10.43%). The same trend was indicated for fat and crude fiber content, with significantly higher ($p<0.05$) for the best sample. This is due to the high fat content in mango seed that increased the crude fat content of fried instant noodles (Yatnatti *et al.*, 2014). According to Menon *et al.* (2014), mango seeds are a source of high-fat food in the range of 8 to 16%. The crude protein content of the fried instant noodle sample was not significantly different compared to the control sample due to the replacement of only 15%, which did not affect the total amount of overall protein content that was mainly contributed by wheat flour.

Table 3: Proximate composition, dietary fibre and energy content of control and best sample instant noodles, n=3

Composition (% DW)	Control	Best Sample
Moisture content	3.43±0.30[a]	3.26±0.18[a]
Ash	10.43±0.48[a]	13.38±0.66[b]
Protein	8.84±0.17[a]	8.17±0.50[a]
Crude Fat	12.37±0.22[a]	15.27±0.69[b]
Crude Fibre	13.11±0.41[a]	14.96±0.20[b]
Total Carbohydrate	51.80±0.21[b]	43.92±2.18[a]
Total Dietary Fibre (%)	5.17 ± 0.33[b]	6.40 ± 0.42[a]
Energy (kcal)	364.23± 4.565[a]	358.59± 3.65[b]

Values in the same row with different superscript letters are significantly different ($p<0.05$)

The total dietary fiber of the best sample was significantly higher (6.40%) than the control sample (5.17%), which is also higher than the study done by Reungmaneepaitoon *et al.* (2009) using 15% oat (4.50%). The result can also be claimed as a rich source of dietary fibers indicated in the Malaysian Food Regulation 1985, which stated more than 6 g/100 g of the sample. The energy content in the best sample was also found to be significantly lower (358.59 kcal) compared to the control (364.23 kcal), confirming that the addition of MS flour can help lower energy content in noodle products (Yatnatti *et al.*, 2014).

3.5 Accelerated shelf life quality of the best MKS instant noodles

3.5.1 Moisture content of stored best instant noodles

Figure 5 showed the moisture content trend of both samples. There were no significant differences (*p>0.05*) found over six weeks of storage in the range of 3 to 4% and followed the moisture content of instant noodles as suggested by Yu *et al.* (2023). This was indicated by the permeability of polypropylene (PP) plastic packaging film against the water vapour surrounding the storage area (Bhatt & Gupta, 2023).

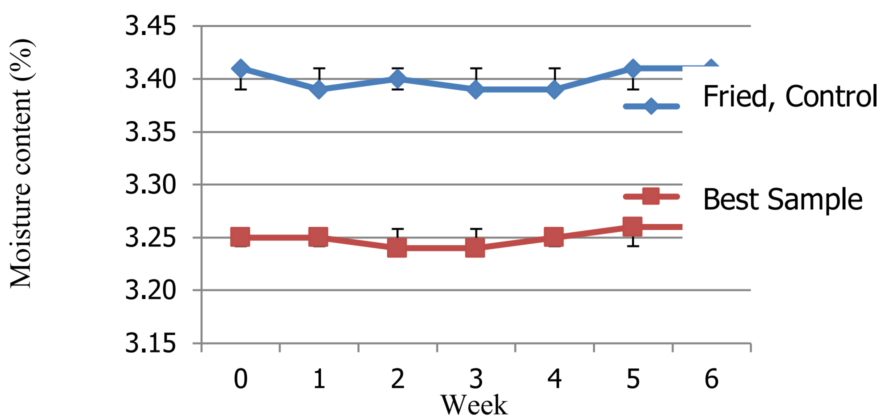

Figure 5: Moisture content trend of control and best instant noodles over six weeks

3.5.2 Microbial status of stored best instant noodles

Microbial status over six weeks of storage of samples showed the yeast and mold count in the range of 3.25×10^1 - 3.41×10^2 cfu/g, indicating that the sample was not suitable for the growth of microorganisms. A low moisture content combined with the use of salt and alkali salt in instant noodles can also be an effective hurdle against the growth of microorganisms (Yu *et al.*, 2023; Li *et al.*, 2014). This result indicated that the fried instant noodle (F2) was still safe to be consumed even after being stored for six weeks. This was due to the low moisture content present in the months, similar to the commercial fried instant noodles (Yu *et al.*, 2023).

3.5.3 Sensory characteristics of stored instant noodles

Throughout over six weeks of storage, the multiple comparison sensory evaluation results indicated that the stored sample was insignificant (*P>0.05*) compared to the fresh sample. A study by Adejunwon *et al.* (2019) showed that the color changes will not affect the storage quality of instant noodles as long as there is no growth of spoilage microorganisms or oxidative rancidity occurs. Bhatt and Gupta (2023) and Ancheta *et al.* (2020) also proved that polypropylene (PP) plastic bags used as a packaging material can prevent the migration of water vapor and oxygen from the surroundings of the storage area. Thus, the storage of instant noodles in airtight PP plastic bags can prevent oxidation of oil that causes rancidity in the instant noodles during storage for six weeks (Wang *et al.,* 2021; Akhigbemidu *et al.,* 2015).

4. Conclusions

Physicochemical of mango seed flour showed better water absorption, better dough stability, increased the peak viscosity but decreased in temperature viscosity peak. Addition of MS composite flour up to 15% into the instant noodle can improve the texture profile, nutrient content
especially dietary fibre and reduced calorie content. Although the addition was influence the colour profile of product but it still can be accepted and remained the good eating quality of the sample. It could be concluded that the fried treatment are preferred to produce the good quality of instant noodle. The mango seed kernel (MKS) composite flour has proven the suitability as secondary ingredient that can be applied in staple food production.

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