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Utilization of Moringa Leaves and Oyster Mushroom Powder to Improve The Nutritional Value of Instant Noodles.

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ABSTRACT

Given their nutritional value, simplicity of preparation, and versatility as a snack at work or school, instant noodles are expanding their consumer base globally. Moringa leaves powder (MLP) and Oyster mushroom powder (OMP) are deployed to increase the nutritional value of instant noodles, which were prepared by wheat flour 72% extraction without adding MLP and OMP (T1), 1% MLP+1% OMP (T2), 2.5% MLP+2.5% OMP (T3), and 5% MLP+5% OMP (T4). Samples were analyzed for their chemical composition, mineral content, total phenols, total flavonoids, antioxidant activity%, texture, color and sensory evaluation. The results illustrated that there is a positive relationship with increasing MLP and OMP, and all of the following contents of protein, fat, crude fibers, and ash. Also, the total phenols, total flavonoids contents, and percentage of antioxidant activity are in direct proportion to the increment level of MLP and OMP in all processed samples, and the highest levels were recorded in T4 (3.32, 1.95, and 25.73, respectively). Adding the MLP and OMP caused an increase in mineral contents, especially Fe, K, and Ca, by 2.7, 1.8, and 34 times that of the commercial sample (CS). The hardness increased gradually with the high levels of MLP and OMP. It worth mentioning, a significant decrease in L* values happened and that the greenness values of instant noodles increased with the increase in MLP and OMP. From the previous results, it could be recommended that (T2), Based upon the findings of the study, the panelists' sensory evaluation, had high nutritional values and thus instant noodles' nutrient content value was increased.

1.Introduction

Instant noodles enjoy widespread consumption globally and are experiencing a rapid growth (Owen, 2001). This is due to their convenience, ease of preparation, affordability, and considerably long shelf-life. Generally, two types of noodles are recognized; the first type is usually white salted noodles made from the following ingredients: flour, sodium chloride, and water. Second type, yellow alkaline noodles are made from alkaline slats (triple sodium phosphate and sodium carbonate) and water (Siah and Quail, 2017).

Typically, the primary components found in many commercially available noodles include wheat flour, sodium carbonate, iodized salt, guar gum, potassium carbonate, sodium polyphosphate, vegetable oil, and tartrazine, which is a synthetic lemon yellow azo dye commonly used as a food coloring agent. In contrast, the spice powder used in these noodles generally consists of iodized salt, monosodium glutamate (MSG), hydrolyzed vegetable protein, garlic powder, soy powder, chicken flavor, and chili powder, as reported by (Sanni et al., 2013).

Numerous health risks have been linked to monosodium glutamate, including gastro intestinal tract disorders. Numerous neurological conditions, including Parkinson's and Alzheimer's, may become worse as a result. Seizures, brain tumors, allergies, rashes, asthma attacks, and damage to brain cells are a few of the possible negative effects of (MSG Blaylock, 1996; Eweka and Om'Iniabohs, 2007).

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After steaming, the instant noodles sold in markets are either fried or dried to remove moisture and are referred to as instant fried noodles or instant dried noodles, respectively. Although dried instant noodles are more commonly favored for their taste, fried quick noodles include more oil. Instant noodles, such as Indomie instant, are simple to make and have a long shelf life (Hou et al*.,* 2010).

Because instant noodles are becoming internationally recognized foods, numerous academics are investigating the possibility of fortifying noodles as an efficient public health intervention and improving its nutritional qualities. The popularity of the noodles can be attributed to many factors like taste, nutrition, convenience, safety, a longer shelf life, and an affordable price (Gulia et al**.,** 2014).

Moringa is known as a drumstick tree (*Moringa Oliefera* lam.), a *Moringaceae* family. It is commonly used as food and medicine in places all throughout the tropical and desert world, from India to Africa in particular (AL Husnan and AL Kahtani, 2016). Moringa is regarded as one of the healthiest trees in the world because to its nearly infinite potential for usage in food, medicine, and industry Khalafalla et al**.,** 2010**;** Padayachee and Baijnath, 2020). Additionally, its leaves are used to cure anaemia, increase milk production in breastfeeding mothers, and as a food supplement to prevent child malnutrition (Anwar et al., 2007). Moreover, Moringa is full of nutrients necessary for growth, it can be used as calcium and protein supplement for milk has twice as much digestible protein and four times as much calcium. The leaves are rich in minerals (Kasolo et al**.,** 2010 and Owon et al., 2021).

Its leaves have a collection of bioactive substances, including phenolic compounds and carotenoids with nutritional and medicinal uses. The leaf of the Moringa tree has a bundle of bioactive substances, including phenolic compounds and carotenoids, which have both nutritional and therapeutic uses (Hamed and El-Sayed, 2019). The shelf life of foods containing fat is increased by the presence of several antioxidant components (Dillard and German, 2000). Additionally, Moringa leaves serve as a strong supply of natural antioxidants and are a protein, vitamin C, and beta-carotene rich source.

The Oyster mushroom (*Pleurotus ostreatus*) is the second-most significant and third-largest commercially produced fungus in the world, accounting for 25% of all farmed mushrooms. It possesses multiple nutritional and medicinal values. The fruit bodies are rich in unique flavor (Boa, 2004 and Obodai et al., 2003). The minerals found in mushrooms are calcium, iron, manganese, zinc and selenium (Alam et al., 2007). Presence of phenolic compounds, tocopherols, carotenes and ascorbic acid makes them a good source of natural antioxidants (Sánchez, 2017).

In addition, mushroom powder is a great source of selenium, chromium, and vitamin D. Muffins and instant noodles benefit from the flavor and sensory qualities of mushroom powder (Fowler et al., 2006 and Arora et al., 2018). With its protein fortification, people's nutritional health can be improved, and protein deficiency in underdeveloped nations can be decreased (Badifu et al**.,** 2005). This research sought to develop wheat, mushroom**,** and Moringa leaves to enhance the value-added product and the nutritional value of the instant noodles.

2. Materials and Methods

Materials

Wheat flour (*Triticum aestivum*) (72% extraction) and the other materials used**,** i.e., sunflower oil, baking powder, onion powder, garlic powder**,** turmeric powder, salt, guar gum, and cardamom**,** were bought from the local marketplaces in Giza, Egypt. Fresh Oyster mushrooms (*Pleurotus ostreatus***)** were obtained from Food Technology Research Institute, Agricultural Research Center. Fresh Moringa leaves (*Moringa peregrina*) were obtained from the Horticultural Research Institute, Agricultural Research Center.

powder, salt, guar gum, and cardamom**,** were bought from the local marketplaces in Giza, Egypt. Fresh Oyster mushrooms (*Pleurotus ostreatus***)** were obtained from Food Technology Research Institute, Agricultural Research Center. Fresh Moringa leaves (*Moringa peregrina*) were obtained from the Horticultural Research Institute, Agricultural Research

Center. Methanol was analytical grade from El-Nasr Pharmaceutical Chemicals Co., Egypt, and DPPH (2, 2-diphenyl-1-picrylhydrazyl), gallic acid, Quersitien, and Folin-Ciocalteu were purchased from Sigma Company (USA).

Technological Methods

Drying of Moringa leaves and Oyster mushroom

Before drying, each fresh Moringa leaves or Oyster mushroom was cleaned, Moringa leaves were then removed from branches, whereas mushrooms were first sliced, then placed on the trays, and then dried in a cabinet dryer at 50°C. The examined raw materials were ground after drying (Parvin et al., 2020).

Preparation of different instant noodles blends

Different instant noodle blends Table 1. were prepared as follows: 1) T1 (the processed control): 100% wheat flour (WF) without adding Moringa leaves powder or Oyster mushroom powder. 2) T2: Wheat flour was fortified with 1% Moringa leaves powder (MLP) and 1% Oyster mushroom powder (OMP).3) T3: Wheat flour was fortified with 2.5% Moringa leaves powder (MLP) and 2.5% **Oyster** mushroom powder (OMP). 4) T4: Wheat flour was fortified with 5% Moringa leaves powder (MLP) and 5% Oyster mushroom powder (OMP). All treatments were mixed with spices (turmeric powder, salt, onion powder, garlic powder, and cardamom) to enhance flavor and color, as well as guar gum, baking powder, salt, and sunflower oil. A commercial sample (CS) was purchased from the local market (national product) to be used for comparison.

Table 1. Formula of different instant noodles blends (g)

Ingredients (g/100g)	Instant noodles Blends			
	T1	T2	T3	T4
WF (72% extraction)	100	98.00	95.00	90.00
MLP	-	1.00	2.50	5.00
OMP	-	1.00	2.50	5.00
Turmeric powder	1.00	1.00	1.00	1.00
Sunflower oil	5.00	5.00	5.00	5.00
Baking powder	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Guar gum	0.50	0.50	0.50	0.50
Onion powder	0.50	0.50	0.50	0.50
Garlic powder	1.00	1.00	1.00	1.00
Cardamom	0.30	0.30	0.30	0.30

MLP: Moringa leaves powder, OMP: Oyster mushroom powder.

Manufacturing of instant noodles

According to (Koh et al., 2022) with certain modifications, all the previous treatments were thoroughly mixed with 50 ml of distilled water. The resulting dough was then shaped into round cushions and with plastic film covering. Following a 20-minute resting period at room temperature (25 ◦C), the dough was kneaded again, rounded, and passed through a noodle- making machine.

The machine's roller gap was adjusted to 2.5 mm, and the dough was sheeted until reaching the number 8 setting, resulting in a sheet of dough that is 0.9 mm thick. The sheeted dough was subsequently cut into noodle strips measuring 2.0 mm in width and 1.0 mm in thickness. These noodles were laid on trays, steamed at 100 ◦C for 20 minutes, and then dried in a hot, air-circulated oven at 70 °C for approximately 3 hours. Finally, the dried noodles were stored in polyethylene bags unless more investigation was done.

Analytical methods.

Chemical analysis of raw materials and different instant noodles blends.

The raw components and various blends of instant noodles underwent chemical analysis to determine their moisture, ash, crude protein, crude fiber, and ether extract contents. The methods outlined in (AOAC, 2012) were followed for this purpose. The quantity of readily available carbohydrates was measured through the difference method, while the energy content (in Kcal) was calculated using the formula provided by (Crisan and Sands, 1978): Gross energy (Kcal) = (9 x crude fat) + (4 x crude protein) + (4 x carbohydrates).

Furthermore, the mineral content of both the raw materials and instant noodles was assessed using the atomic absorption spectrophotometer No. 3300 (PerkinElmer, USA), following the method described in (AOAC, 2005). This analysis enabled the determination of mineral composition.

Determination of total phenolic compounds (TPC), total flavonoids (TF) and antioxidant activity (by DPPH scavenging) of raw materials and different instant noodles blends.

(Singleton et al., 1999) employed the Folin-Cicalteau method to measure the total phenolic compounds (TPC). This method relies on the colorimetric oxidation/reduction process of phenols. Gallic acid was used to create a calibration curve, and the results were expressed as milligrams of equivalent gallic acid (GAE) per gramme of dry weight (D.W.) to determine the total flavonoids, (Zhuang et al., 1992) utilized a specific technique for extraction and measurement. The calibration curve was established using quercetin as an example compound, and the results were presented as milligrams of quercetin equivalent (Que) per gram of dry weight (D.W.). Furthermore, the antioxidant activity of both free and bound phenolic extracts was evaluated using the DPPH scavenging method, as previously depicted by (Hung and Morita, 2009). This method allowed the assessment of how well the extracts work to neutralize DPPH radicals and measure their antioxidant potential.

Color measurements

At three distinct locations on the sample, the color of dried instant noodle samples was assessed using a chroma meter in accordance with the procedure outlined by (Kamble et al., 2021) and (Minolta CR 400, Minolta Camera, Co., Osaka, Japan) features a D65 illuminant and an 8 mm measuring head. The manufacturer's standard white plate was used to calibrate the chroma meter. The L*, a*, and b* color spaces were used to quantify color shifts. Before reading, a typical white ceramic plate was used to calibrate the calorimeter. Color changes (ΔE) were assessed from the following equation.

$$\Delta E^* = \sqrt{(L_1^* - L_0^*)^2 + (a_1^* - a_0^*)^2 + (b_1^* - b_0^*)^2} \qquad (1)$$

Here, subscript 0 designates the MLP and OMP-fortified instant noodles sample or control (T1) while subscript 1 designates the commercial sample (CS).

Texture profile analysis.

The texture measurement of dried instant noodles samples was measured by a universal testing machine (Cometech, B variety, Taiwan). On noodles put over a 3-point support with a punch diameter of 5.3 mm and a distance between points of 15mm, a punch test was conducted. A 60 mm/min cross-head speed was used. Utilizing computer software, the maximum breaking force and deformation were determined from the force-deformation curve, which was recorded. The probe speed was 1mm/s^{-1}, according to (Bourne, 2002). Hardness values are denominated in Newtons (N).

Sensory evaluation

The instant noodles were cooked according to (Koh et al., 2022) in distilled water at 100 ◦C (10g/L). After two minutes of boiling the noodles, the cooked samples were evaluated organoleptic ally by ten panelists from Horticulture, Crops Tech. Res. Dept., Food Tech. Research Institute, Agriculture Research Center, Giza, Egypt.

A nine-point hedonic scale, with 9 denoting high level of acceptance and 1 denoting severe non-acceptance, was used by the panelists to rate the samples' characteristics like appearance, flavor, taste, texture, and overall acceptability. (Liu et al., 2019).

Statistical analysis

According to (Steel et al., 1997), the statistical analysis was performed using a one-way analysis of variance (ANOVA) under a significant threshold of 0.05 for the entire set of findings using the statistical application CoStat (Ver. 6.400). The LSD test was used to determine the significance between different samples.

3. Results and Discussion

Chemical composition of raw materials (Wheat flour, Moringa leaves mushroom powders)

This study tested the moisture, ash, lipid, and protein content of three powders: wheat flour (WF), Moringa leaves powder (MLP), and Oyster mushroom powder (OMP). The outcomes are shown in 2. The wheat flour contains moisture (14.73%), total ash (0.63%), fat (0.84%), Crude protein (9.15%), crude fibers (0.78%), and available carbohydrates (86.76%). These values are within the bounds of (Abd El-Ghany, 2020), who found that wheat flour (72% extraction) contains 12.60% moisture, 12.25% protein, 0.70% lipids, 0.63% total ash, 0.64% crude fibers, and 85.78% carbohydrates. Carbohydrates, the findings of their studies are more or less in agreement with the values obtained in Table 2. On the other hand, results illustrated that OMP contains moisture (9.76%), ash (7.73%), fat (1.98%), protein (29.06%), and available carbohydrates (50.99%). These findings lie within the outcomes reached by (Abou Raya et al., 2014) who reported that dried Oyster mushrooms contained 26.05% of crude protein, 2.79% of crude fat content, 9.65% of moisture content, 5.86% of ash, 8.25 % of crude fibers, and 57.05% of carbohydrate (by difference). The genetic makeup of species, as well as physical and chemical variations in the growing media, could all contribute to the variations in results (Agrahar-Murugkar and Subbulakshmi, 2005).

Table 2. Chemical composition (%) of raw materials (WF, OMP and MLP) on dry-weight basis

Parameters	Raw materials		
	WF*	OMP	MLP
Moisture (%)	14.73a±0.26	9.76^{b}±0.24	6.41^{c}±0.21
Total ash (%)	0.74 ^{c}±0.09	7.73 ^{b}±0.15	13.68^{a}±0.53
Fat (%)	0.99 ^{c}±0.04	1.98 ^{b}±0.09	4.20 ^{a}±0.29
Protein (%)	10.73 ^{c}±0.62	29.06 ^{b}±1.68	33.56 ^{a}±1.79
Crude fibers(%)	0.78^{c}±0.02	10.24^{b}±0.12	20.00^{a}±0.17
Available carbohydrates (%)*	86.76 ^{a}±1.39	50.99 ^{b}±1.39	28.56^{c}±2.45
Zn (mg/100g)	7.21	6.08	30.52
Cu (mg/100g)	1.89	10.21	8.24
Ca (mg/100g)	31.4	106.41	1100
K (mg/100g)	815.25	1089.13	2157.34
Mn (mg/100g)	5.21	11.73	18.53
Fe (mg/100g)	2.41	15.12	40

*Available carbohydrates calculated by difference.
WF: Wheat flour (72% extraction), MLP: Moringa leaves powder, OMP: Oyster mushroom powder.
The values represent the means ± the standard deviations, based on three separate measurements.
The means displayed in the same row, but with different superscripts indicate that they are statistically distinct from each other, with a signifi-

Also, (Farooq et al., 2021) reported that protein, fibers, fat, ash, and carbohydrate in WF were 9.45, 0.30, 1.25, 0.35 and 76.15, respectively. Whereas the same previous parameters of OMP were 28.69, 8.16, 1.88, 6.09 and 47.82, respectively. Table 2. also shows that moisture, protein, fat, ash, crude fibers and available carbohydrates of MLP (Table 2.) reached about 6.41, 33.56, 4.20, 13.68, 20.00, and 28.56%, respectively. These results were near those mentioned by (El-Nabey and Sharara, 2015; Shokry, 2017) who showed that crude fiber, crude protein, and carbohydrate were 22.87, 31.73, and 32.07, respectively. Also, (Olson et al., 2016) showed that Protein content in 100g dry weight of Moringa leaves ranged from 29.1 to 35.3 g. On the other hand, (Yameogo et al., 2011 and Teixeira et al., 2014) reported that the flour of *Moringa oleifera* leaves had 25% to 28.7% crude protein, 5.4% to 11.4% fat, 8.4% to 10.9% ash and about 44% carbohydrates. It could be noticed that the mushrooms and MLPs showed a high amount of ash and protein, which could be used in the substitution of WF in food items to boost their nutritious content. Also, Moringa and mushroom powders are rich in fibers which are an important parameter in a healthy diet. In addition to protecting against some malignancies and improving digestive health, it aids in the prevention of heart disease, diabetes, and weight loss.

Data in Table 5. show that MLP had the highest scores of the examined minerals, followed by OMP and flour. MLP contained 1100, 2157.34, 40, 8.24, 18.53, and 30.52 mg/100g of Ca, k, Fe, Cu, Mn, and Zn, respectively, while OMP showed 106.41, 20.41, 15.12, 10.21, 11.37, 1089.13, 23.08, and 10.6, respectively. Our data were similar to those of (El-Gammal et al., 2016 and Hussin et al., 2020), who recorded that the mineral content of MLP was 1390, 1700, 40.51, 9.30, and 7.80 mg/100g for Ca, K, Fe, Zn, and Cu, respectively. The assay showed that MLP was a great source of Ca, K and Fe. On the other hand, the mushroom was rich in minerals, especially K, Ca, and Fe. Data in the table show that Fe content in OMP reached about 15.12 mg/100g, the results were close to those cited by (Agbagwa et al., 2020 and Ibrahim et al., 2022). Besides these macro elements, OMP contains many microelements, such as Zn, K, Cu, and Mn.

Chemical composition of prepared noodles

The approximate composition of prepared noodles is shown in Table 3., is moisture, ash, fat, protein, and available carbohydrates of processed instant noodles compared to the commercial sample. From the table, it was noticed that all treatments varied in moisture (7.39 – 8.7 6%). Based on the findings of (Puwani et al., 2006), maintaining a low moisture content range of 6.32-10.86% in food products can enhance their shelf-life stability. This is achieved by inhibiting microbial growth and minimizing chemical reactions that can occur during storage. Also, all treatments increased gradually in ash and protein, according to WF replacement with Moringa leaves and mushroom powder, which are rich in protein and ash. The highest significant values of ash and protein belonged to T4 (2.33% and 12.41%, respectively). Protein increased in T4 (5% Moringa and 5% mushroom) by 25% comparing to the commercial sample, there was a significant difference. On the other side, % total ash increased significantly by 102%, because both Moringa and mushrooms are rich in minerals and vitamins. (Hong et al., 2005) mentioned that the protein in bread increased when mushroom powder was added, possibly due to the high protein amount in mushroom powder. Table 3. indicates that the highest level of total fat was significant in CS (16.97) compared to other treatments but processed instant noodles from T2 to T4 increased compared to T1 with a high concentration of Moringa, and the treatments of processed noodles (T1, T2, T3 and T4) decreased significantly in total fat as they were dried after processing to be healthier than frying.

On the other hand, % crude fibers varied among treatments, and there were increments directly associated with the increase of MLP and OMP, especially in T4, T3 and T2, one possible explanation for this phenomenon could be the abundant presence of powder. After fortification with various concentrations of Moringa flour, Both Páramo-Calderón et al., (2019); Getachew and Admassu (2020), observed on their research on pasta, and tortillas fortified with Moringa flour, that there was a consistent pattern of elevated levels of ash, fat, protein, and fiber content . Our findings concurred with those of Our findings concur with those of (Parvin et al., 2020), who found a similar tendency for pasta supplemented with mushrooms. According to earlier research, foods high in healthy fat enhance flavor, whereas foods fiber increase satiety, assist in controlling many biological processes and shield against a range of illness syndromes like diabetes, cancer, diarrhea , and cardiovascular disease (Benhur et al., 2015; Kamble et al., 2019).

Table 3. Chemical composition (%) of prepared instant noodles on dry weight basis

Parameters	Treatments				
	CS*	T1	T2	T3	T4
Moisture (%)	6.15^{d}±0.22	8.76^{a}±0.36	8.59^{a}±0.23	8.02^{b}±0.19	7.39^{c}±0.07
Total ash (%)	1.15 ^{d}±0.07	1.50 ^{c}±0.16	1.66 ^{bc}±0.11	1.77 ^{b}±0.19	2.33 ^{a}±0.16
Fat (%)	16.97^{a}±0.1	5.09^{c}±0.23	5.20 ^{bc}±0.20	5.82 ^{bc}±0.51	5.90 ^{b}±0.36
Protein (%)	9.95^{d}±0.39	10.05^{cd}±0.04	10.76^{bc}±0.34	11.14^{b}±0.65	12.41^{a}±0.61
Crude fiber (%)	0.49^{d}±0.12	0.53^{cd}±0.11	0.76^{c}±0.10	1.64^{b}±0.08	2.53^{a}±0.2
*Available carbohydrates (%)	71.44^{e}±0.54	82.64^{a}±0.17	81.62^{b}±0.62	79.63^{c}±0.08	76.83^{d}±0.07
Energy (Kcal)	478.29^{a}±1.6	417.33^{b}±0.59	416.32^{b}±0.68	415.46^{b}±2.30	410.06^{c}±0.99
Zn (mg/100g)	10.03	10.52	11.07	13.43	15.75
Cu (mg/100g)	1.94	2.07	2.22	2.34	2.86
Ca (mg/100g)	2.3	30.4	55.4	60.7	80.4
K (mg/100g)	1061.92	1086.25	1113.64	1348.49	1973.53
Mn (mg/100g)	5.34	6.22	7.76	8.52	10.00
Fe (mg/100g)	19.91	20.98	22.95	27.39	54.9

*Available carbohydrates calculated by difference
**CS: commercial sample,
T1: Instant noodles processed with only flour and spices without Moringa or mushroom,
T2: Instant noodles processed with flour, spices, 1% Moringa, and 1% mushroom,
T3: Instant noodles processed with flour, spices, 2.5% Moringa, and 2.5% mushroom,
T4: Instant noodles processed with flour, spices, 5% Moringa, and 5% mushroom.

Accordingly, the available carbohydrates (calculated by differences) increased in all treatments, because of the increased levels of OMP and MLP. Our results agree with (Zula et al., 2021). The range of gross energy was 478.29 kcal to 410.06 kcal. According to our research, instant noodles produced from powdered Moringa leaves and mushrooms had less energy than the commercial sample. The higher gross energy in the commercial sample (CS) may be due to the higher content of total fat. The protein and carbohydrate content showed a similar attendance, aligning with the results found by (Hannan et al., 2014) in their study on Moringa fortified cookies. In instance, the quick noodles enriched with Moringa and mushrooms had a greater nutritional profile than the control sample, proving thier successful in creating nutrient-dense, shelf-stable instant noodles.

The addition of each MLP and OMP with 1, 2.5, and 5% caused an increase in Fe content from 20.98 mg/100g for control to 22.95, 27.39, and 54.9 mg/100g for processed samples. These findings concurred with those of (El-Gammal et al., 2016), who illustrated that the content of P, Ca, Mg, and Fe in various pan bread samples supplemented with MLP resulted in higher mineral content compared with control samples. Also, (Mouminah, 2015) revealed that the high amounts of minerals in treatments possibly as a result of the high content values of minerals in MLP, which fortified the noodles.

Total phenolic compounds (TPC), total flavonoid (TF) contents and antioxidant activity (%) of raw materials.

Bioactive compounds, including flavonoids, phenolic acids, and tannins, have been tested for their potential health benefits and high antioxidant capacity. Also, these compounds can improve the quality of life and have been used for centuries to maintain human health (Del Rio et al., 2010).

Fig. 1 (A and B) shows that MLP had the highest TPC, TF, and DPPH, which were 36.28 mg/g GAE, 25.79 mg/g Que, and 67.77%, respectively. These data were on board with those stated by (Owusu-Ansah et al., 2011), who stated that total phenolic contents ranged from 24.14 ± 0.91 mg/g GAE to 58.98 ± 0.28 mg/g GAE. On the other hand, TPC, TF, and antioxidant activity of OMP reached about 7.17 mg/g GAE, 2.29 mg/g Quercetin, and 24.82%, respectively, which were near (Alispahi et al., 2015), who mentioned that TPC of mushrooms was between 7.8 and 23.07 mg GAE g-1.

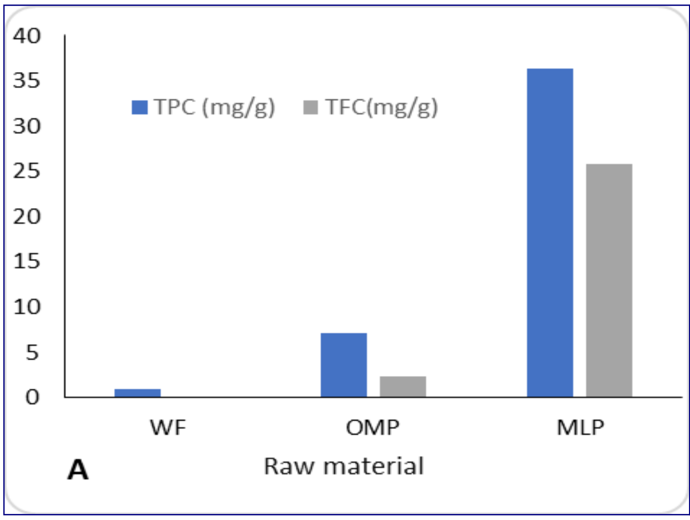

Figure 1. (A) Total phenols and Total flavonoids (mg/g) of raw materials (WF, OMP and

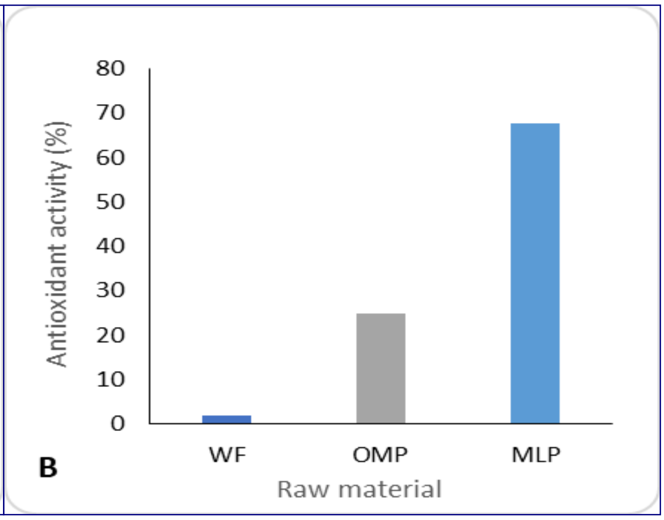

Figure 1. (B) Antioxidant activity (%) of raw materials (WF, OMP and MLP).WF, Wheat flower, OMP, Oyster mushroom powder, MLP, Moringa leaves powder.

Figure 2. (A and B) depicts the concentrations of TPC, TF, and antioxidant activity % by DPPH scavenging, of CS and the processed instant noodles. It can be noticed that each of the total phenols, total flavonoids, and % antioxidant activity significantly increased from 0.85, 0.29, and 9.89 to 3.32, 1.95, and 25.73 mg/g, respectively, among the processed noodles treatments in direct proportion with the increasing MLP and OMP concentrations. The highest values of total phenols, total flavonoids, and %antioxidant activity were significant for T4 (3.32, 1.95, and 25.73, respectively), followed by T3 (2.61, 1.14, and 20.14, respectively). Previous results consistent with those of (El-Refai et al., (2021), who revealed that adding Moringa and turmeric powders increased the bio-active compounds; especially total phenols, total flavonoids, and DPPH scavenging in pan bread. (Simonato et al., 2020) reported that Moringa leaves powder levels (0%–15%) increased TPC in pasta.

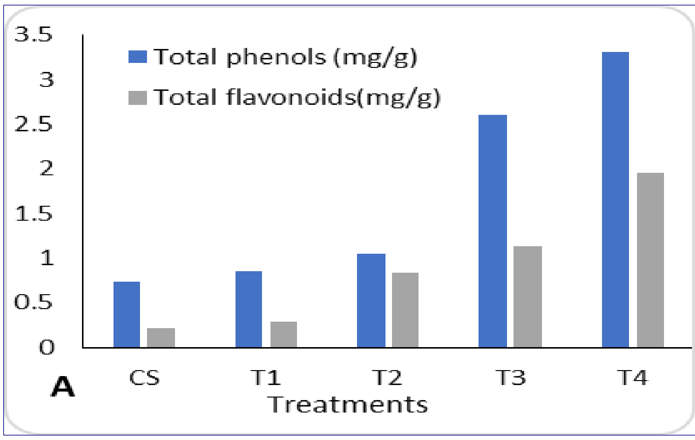

Figure 2. (A) Total phenolic compounds (TPC) and total flavonoid (TF) (mg/g) of noodles instant (treatments).

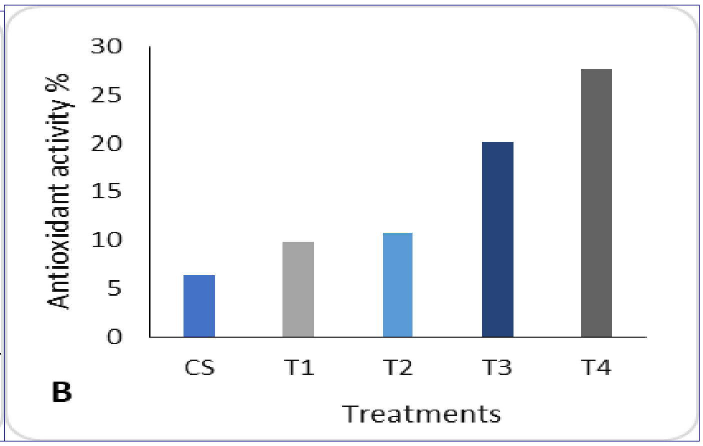

Figure 2. (B) Antioxidant activity (%) of instant noodles (treatments).

Meanwhile, the lowest significant values of TPC, TF and % antioxidant activity (0.74, 0.21, and 6.43, respectively) were for CS. It may be concluded that the increments in antioxidant capacity of all processed noodles (Figure 2.) are related to their total phenols and total flavonoids, which are related to the presence of Moringa, a plant renowned for its high concentrations of natural antioxidants like vitamin C, carotenoids, tocopherols, and micronutrients (zinc and selenium) that may aid in boosting antioxidant activity (Falowo et al., 2018).

Phenolics possess several health properties, it also retains flavor, taste, and color and prevents their oxidative deterioration (Bhat and Gupta, 2015). It also retains flavor, taste, and color and prevents their oxidative deterioration. The elevated amounts found in processed noodles are caused by antioxidants that naturally exist and are already present in MPL and MP. (Muhammad et al., 2016) claim that the presence of flavonoids like kaempferol and quercetin in *M.oleifera* Pods assist diabetics' serum insulin levels rise and their glucose levels fall, in addition to increasing antioxidant activity. From these results, it's highly suggested that instant noodles fortified with MLP and OMP can be used to provide bioactive substances to enhance human nutrition.

Sensory evaluation of instant noodle samples

Sensory evaluation has an extremely important role in quality food evaluation due to the fact that it measures what people actually feel and the substantial characteristics related to quality like flavor, color, taste, and texture (Bryhni et al., 2002). The sensory properties of noodles using different ratios of MLP and OMP were estimated to select the best quality noodles.

Table 4. Sensory evaluation of instant noodles

Sample	Appearance	Odor	Taste	Color	Texture	Overall acceptability
CS	$9.08^{a}\pm0.90$	$9.25^{a}\pm1.14$	$8.67^{a}\pm1.50$	$8.33^{a}\pm1.23$	$8.17^{a}\pm1.53$	$8.38^{bc}\pm1.19$
T1	$9.08^{a}\pm0.79$	$8.71^{a}\pm1.05$	$8.62^{a}\pm1.11$	$8.36^{a}\pm0.77$	$8.50^{a}\pm1.17$	$8.54^{b}\pm0.92$
T2	$8.88^{a}\pm0.91$	$8.58^{a}\pm0.82$	$8.62^{a}\pm0.57$	$8.33^{a}\pm0.33$	$8.83^{ab}\pm0.83$	$9.36^{a}\pm0.61$
T3	$7.50^{b}\pm0.80$	$7.25^{b}\pm0.87$	$7.42^{b}\pm0.76$	$7.17^{b}\pm0.94$	$7.46^{cb}\pm1.50$	$7.67^{c}\pm1.07$
T4	$6.79^{c}\pm0.78$	$6.50^{b}\pm1.17$	$6.12^{c}\pm1.00$	$6.50^{b}\pm1.09$	$6.83^{c}\pm0.94$	$6.46^{d}\pm0.84$

CS: Commercial sample. T1: Instant noodles processed with only flour and spices without Moringa or mushroom,
T2: Instant noodles processed with flour, spices, 1% Moringa, and 1% mushroom,
T3: Instant noodles processed with flour, spices, 2.5% Moringa, and 2.5% mushroom,
T4: Instant noodles processed with flour, spices, 5% Moringa, and 5% mushroom.
The values represent the means ± the standard deviations, based on three separate measurements.
The means displayed in the same row, but with different superscripts indicate that they are statistically distinct from each other, with a significance level of $p\geq0.05$.

Organoleptic criteria like appearance, texture, color, taste, odor, and overall palatability are shown in Table 4. It could be observed that T2, with 98% WF, 1% MLP, and 1% OMP, was the most preferred by the panelists, and there were no notable variations between T2 and T1 or CS, while T4 scored the lowest values in all parameters. T4 was the treatment that was not preferred; it had a dark color and less overall palatability than T3 and other treatments. These results are agreed with (El-Refai et al., 2021), who claimed that adding Moringa and turmeric as natural colorants reduced all sensory characteristics in bread samples.. On the other hand, the results agreed with those recorded by (El-Gammal et al., 2016; Abd El-Ghany and Eraky 2019), mentioned that the texture, flavor, and general acceptance of pan bread improved as a result of the addition of Moringa powder.

Effect of treatments on texture of processed instant noodles

Figure 3. shows the texture measurement of instant noodles compared to a commercial sample. The results revealed that both tested noodles (T1, T2, and T3) and the control sample showed remarkably lower values of hardness and recorded 1.77, 2.28, 2.43, and 2.03 Newton, respectively, than T4, which got the higher score of hardness values. The incorporation of Moringa and mushroom powders caused a significant increase in the hardness of noodles, which may refer to their hygroscopic properties and the higher fiber content in both Moringa and mushroom powders. Data illustrated by (Zhang et al., 2019 and Slawinska et al., 2022) showed that increasing OMP substitution led to a significant increase in texture properties, including crumb and hardness. On the contrary, T1 samples were characterized by the lowest hardness (1.77).

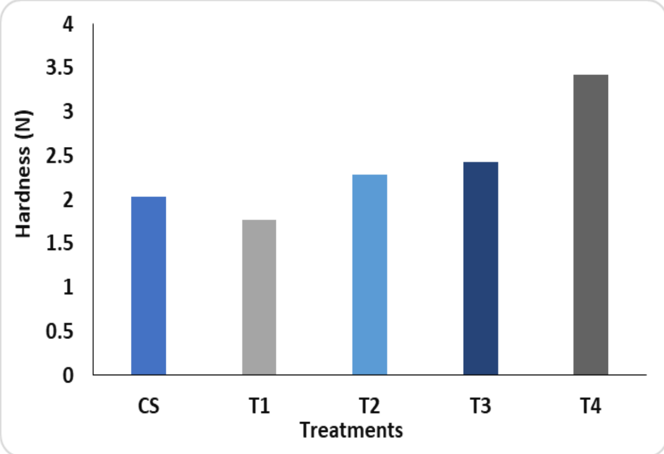

Figure 3. Texture measurement of processed instant noodles.

Color measurement of instant noodles samples

A product's look and color measurement are crucial quality requirements for consumer approval. According to (Fu, 2008), noodles should be colorful and slow to age. The color is influenced by the level of flour fineness, the usage of alkaline formulas, and the enzymatic browning caused by the enzyme polyphenol oxidase (Asenstorfer et al., 2006). Noodle color will be measured by using the color meter, which shows the color characteristics of noodles at different concentrations of MLP and OMP.

Table 5. Effect of treatments on instant processed noodles color

Code	L*	a*	b*	Δ E
CS	$70.18^{a\ b}$ 1.40	-0.09^{a}±0.48	50.33^{a}±2.91	0
T1	53.3^{b}±3.69	-0.38^{a}±0.57	37.79^{b}±3.28	30.22^{b}±1.94
T2	44.37^{c}±2.83	-1.42^{b}±0.11	31.28^{c}±1.44	31.86^{b}±2.24
T3	38.12^{d}±1.18	-2.14^{b}±0.56	23.79^{d}±1.85	34.72^{b}±1.06
T4	27.67^{e}±5.28	-3.06^{c}±0.11	23.43^{d}±2.47	47.68^{a}±2.96

CS: commercial sample,
T1: Instant noodles processed with only flour and spices without Moringa or mushroom,
T2: Instant noodles processed with flour, spices, 1% Moringa, and 1% mushroom,
T3: Instant noodles processed with flour, spices, 2.5% Moringa , and 2.5% mushroom,
T4: Instant noodles processed with flour, spices, 5% Moringa, and 5% mushroom.
The values represent the means ± the standard deviations, based on three separate measurements.
The means displayed in the same row, but with different superscripts indicate that they are statistically distinct from each other, with a significance level of $p \geq 0.05$.

Outcomes present marked variation in chroma meter values between the noodle samples. There is a significant decrease in L* values of instant noodles color with the increase in MLP and OMP levels, which results in a reduction in the noodles brightness. As the mixed powder increased as tabulated, the color became darker, which decreased L* values. The information is agreement with the study of (Khojah et al., 2017) that looked at the color features of noodles which had been supplemented with broccoli powder and found that as the amount of broccoli powder rose, the noodles' appearance became darker. The redness (a) and yellowness (b) levels of each sample varied. As the Moringa and mushroom powder content increased, the greenness values increased significantly, while the yellowness values decreased significantly. These results agreed with (Hammad and Abo-Zaid, 2020), who discovered that turning up the amount of turnip leaf powder boosted the noodles' green hue.. ΔE for T1, T2, T3 and T4 samples were 30.22, 31.86, 34.72, and 47.68. It means that the color changes and is visible. These results demonstrated that mixtures decreased lightness and yellowness while increasing greenness.

4. Conclusion and recommendations

The addition of MLP and OMP to the instant noodles enhanced their nutritional values by increasing total phenols and their antioxidants activity, increasing their content of crude fibers, and reducing calories. Besides, MLP and OMP affected technological properties like hardness and color, so it is recommended to use the second treatment (1% Moringa, and 1% mushroom) as it was the most preferred by panelists. The present findings supported the hypothesis, that MLP and OMP could represent valuable ingredients to improve instant noodles' nutritional properties.

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