Original Research Article

Development of ready to cook banana pseudo stem vermicelli upma mix with quality evaluation

Abstract

The present research aimed to evaluate the effect of incorporation of commonly discarded part banana pseudo stem (BPS) for the development of ready-to-cook (RTC) vermicelli upma mix. BPS was subjected to preliminary treatment with citric acid solution (0.5%) to prevent an enzymatic browning reaction during the preparation of flour. Vermicelli was prepared by partial substitution of whole wheat flour and semolina with BPS flour at the level of 5, 10, 15, 20 and 25% (T_1, T_2, T_3 & T_4). Effect of incorporation of BPS flour on- the physical, functional and organoleptic properties were studied. Among all the variations tested T_3 (20%) was accepted with optimal cooking characteristic hence, taken for preparation of vermicelli BPS upma mix and compared with control. The BPS vermicelli upma mix has got significantly more ash (27.2 g), soluble fiber (2.64 g) and insoluble fiber (15.76 g) and also rich in minerals such as potassium (1203.6 mg %) and calcium (5.72 mg %). It also contained higher antioxidant activity (3.93 mg %), total phenols (583.44 mg GAE %), saponins (291.06 mg %), tannins (4.01 mg %) and flavonoid (165.7 mg %). However, vermicelli upma mix was packed in MMP and LDPE pouches and stored at ambient conditions (25 ± 5^0C) for a period of six months.

Keywords: Banana pseudo stem, Biowaste, Vermicelli upma mix, Antioxidants, Total phenols.

Introduction

Banana is an herbaceous plant that belongs to the family Musaceae. Bananas are widely produced in tropical and subtropical countries in the world (Ahmad et al., 2018). It is the world's second most produced fruit in the world, accounting 16 % of global fruit supply (Mohapatra et al.,2010). Almost all the parts of banana plant are utilized, for example, fruit, peel, leaf, pseudo stem, stalk, and inflorescence. The pseudo-stem of banana plant is the stem

part of banana plant that transports nutrients from the soil to the fruit. After banana fruit is ripe and harvested, the stem is cut which becomes waste biomass as the banana plant is unusable for the next harvest (Mohapatra *et al*., 2010). For every ton of banana fruit harvested about 4 tons of biomass waste is produced. This means for every cycle of banana fruit production four times of biomass waste is produced (Bhaskar *et al*.,2011). If they are dumped in wet conditions or burned can produce greenhouse gas which can cause a problem to the environment. It is believed that this crop waste can be used in a more rational way namely, as a source of cellulose fiber for further applications (Lakshman *et al*.,2015). Hence, central core of banana pseudo stem can be consumed as food source which is traditionally utilized as food ingredient in Indian cuisines and eaten as vegetable in Southern Asia and Indo-Malesian Region (Mohapatra et al.,2010). It is also used in making candies, biscuits, brownies, cookies and pickles (Kaddumukasa *et al*.,2005) (Lakshman *et al*.,2015) anf RTS beverage (Buvaneshwari et al 2020). Also, it is the only plant source with most abundant starch content which has the potential to be processed into flour (Aziz *et al*.,2011), (Lakshman *et al*.,2015, Aziz *et al*.,2013, Sangroula*et al*., 2018) which is used in a variety of baked goods, soups, and other dishes (Kaddumukasa *et al*., 2005). Banana pseudo stem has various health benefits. It is rich source of fiber, low glycaemic index which helps in weight loss and controlling diabetes due its nutritional fiber. Consumption of a lot of dietary fiber is beneficial to human health. It is also high in potassium which is essential for proper muscle function, cardiac muscle function and help in preventing high blood pressure and aids in maintaining body fluids. (Neog *et al*.,2013 and Singh *et al*., 2018). In addition, BPS also contains significant amount of vitamin B6, which aids in producing haemoglobin and insulin thus help in improving body to prevent infection It also acts as diuretic which detoxification of body and also prevent the kidney stones(Raju *et al*.,2019). Banana pseudo stem core is mostly composed of 90 % moisture, making it impossible to be stored for a longer duration which rapidly undergoes enzymatic reaction turning to brown leading to affect the sensorial properties and economic value. Hence, it needs to be processed to improve its nutritional and sensory qualities. It also aids in improving the essential macro and micro minerals which is seen in white bread, pastry products, brownies. Hence, it is described as food with less balanced nutrients and lower food value (Kaddumukasa *et al*., 2005). Due to accelerated speed of modern living, there is a greater awareness of health and a preference for convenience ready to cook (RTC) foods is increasing. Foods that have undergone major processing by the manufacturer such that they require little cooking before consumption are called as “RTC foods” (Rahman Tazyn, 2012).

Vermicelli is a popular and widely consumed food item that falls under the extruded product and is made from wheat flour and semolina. BPS flour can be partially replaced with wheat flour which increases the dietary fiber with various health benefits. Vermicelli upma is one of the highly consumed breakfast in India which is prepared through the addition of vegetables like carrot, beans, onion which help to feel full and satisfied for longer period. Due to lengthy and tedious method of preparation developed innovative "RTC instant upma mixes."

Hence, the study was taken up with an objective to standardize methodology for BPS flour preparation and to assess the physiochemical and sensorial properties of BPS incorporated vermicelli upma mix.

MATERIALSAND METHODS

Fresh banana pseudo stem (BPS) was procured from local vegetable market in Yelahanka, Bangalore. The other ingredients used in the study like wheat flour, semolina and salt were procured from the local market in a single lot and refrigerated until use.

Preparation of Banana Pseudo stem Flour (BPS) and UPMA mix:

As Banana Pseudo stem undergo enzymatic browning reaction hence, the procedure of preventing browning the pre-treatment of slices with citric acid was followed. The banana pseudo stem was dried at 60 ^{0} C for 30 hrs. The dried banana pseudo stem (BPS) powder was incorporated into vermicelli. Whole wheat flour and semolina were used for the preparation of the control sample. The composite flour blends were prepared by substituting the whole wheat flour (WWF) and semolina (SL), while the rest of the treatments were substituted with 5% (T_1), 10% (T_2), 20% (T_3) and 25% (T_4) of BPS flour along with WWF and SL. The extruded vermicelli was mixed with shallow fried Bengal gram dhal, mustard seeds, dehydrated green chili, onion, carrot, beans, coriander and curry leaves to make it an RTC upma mix.

Proximate and physicochemical estimation

Control (without the addition of BPS flour) and BPS vermicelli upma mix (T_3) were analyzed for proximate composition namely moisture, ash, energy, crude fat and crude fiber according to the standard procedures described by Ranganna (1986). The carbohydrate content was calculated by different method. Estimation of minerals such as calcium, magnesium, sodium, potassium, phosphorous, manganese, iron and zinc were estimated according to the standard AOAC (2005) method.

Estimation of total phenolic content

The total phenolic content in the ethanolic extract of BPS vermicelli upma mix (T_3) was determined spectrophotometrically using folin-ciocalteu method as described by Onivogui *et al*, (2014) with slight modification. The amount of total phenol was expressed as gallic acid equivalent (GAE) in milligrams per gram of sample.

Estimation of total flavonoid

Aluminum chloride assay was used to determine the total flavonoid content with slight modifications. The total flavonoid content was determined from standard curve prepared using different concentrations of quercetin standard and expressed as mg quercetin equivalent (QE)/100g of the sample weight. The total flavonoid content (TFC) of the extract was determined according to Onivogui *et al*, (2014). The total flavonoid content was expressed as mg quercetin equivalents per 100 ml of BPS vermicelli upma mix (T_3) as well as control.

Total antioxidant activity by DPPH assay

The ability of the different solvent extracts to scavenge free radicals was determined against a very stable free radical DPPH (1, 1-diphenyl-2-picrylhydrazyl) spectrometrically at the wavelength of 517 nm. The total antioxidant activity was determined from a standard curve prepared using different concentrations of DPPH solution and expressed as a percentage DPPH radical scavenging activity (RSA) in triplicates using ascorbic acid as the standard (AOAC, 2005)

Estimation of saponin content

The procedure for the estimation of saponin was adopted from Hai *et al*. (2012). The absorbance of the mixture was measured by a spectrophotometer at a wavelength of 544nm. Diosgenin was used as a reference standard. Saponin concentration was obtained from the standard graph.

Saponin content (mg/100 g) $= \frac{Absorbance of sample \times gradient of grph}{weight of the sample\ (g)}$ x 100

Estimation of tannins

After dissolving the extract in 5 mL of distilled water, 1 percent gelatin solution and 10 % NaCl were added. The presence of tannins was revealed by the formation of a white precipitate (Joshi and Awasthi 2022).

Cooking characteristics of BPS vermicelli

Optimum cooking time

The control and BPS vermicelli samples (5 g) were cooked in boiling water (100 mL) over a gas stove. The optimum cooking time for vermicelli were determined subjectively by pressing the product between fingers periodically at two-minute intervals. When the product was completely soft, the time was noted as optimum cooking time as per Jalgaonkar *et al*. (2019). The experiment was repeated for three consecutive times in order to get accurate value.

Swelling power

Swelling power of control and BPS vermicelli samples were determined by the method proposed by Schoch (1964). A known weight (5 g) of cold extrudates were cooked in a glass beaker with 10 times it's quantity of boiling water (50 mL) for 5 minutes over a water bath maintained at 100 °C. After cooking, the water was strained out and the cooked vermicelli were dried to remove surface moisture using filter paper and the cooked vermicelli were weighed. From the initial and final cold extrudates weights, swelling power was calculated as:

$$\textbf{Swelling power (g/g)} = \frac{W1-W2}{W1}$$

where,

W_1 = Sample weight before cooking (g)

W_2 = Sample weight after cooking (g)

Solid loss

Solid loss was determined by cooking vermicelli sample in boiling water for 20 mins. After cooking, the cooked materials were strained out and the whole filtrate was transferred

quantitatively into a pre-weighed petri dish. It was evaporated over a water bath followed by drying in a hot air oven maintained at 105 ± 2 °C for 1 hour. The Petri dish was weighed again with the dried solids as per Jalgaonkar *et al*. (2019). Then, the solid loss was calculated as:

$$\textbf{Solid loss (\%)} = \frac{m2 - m1}{m0}$$

where,

m_0 = Initial weight of cold extrudates taken for cooking (g)

m_1 = Weight of empty petri dish (g)

m_2 = Weight of petri dish with dried solids after evaporation (g)

Storage studies

The developed BPS vermicelli upma mix (T3) and control vermicelli upma mix were stored in MPP (Metalized polypropylene) and LDPE (low-density polyethylene) pouches for a period of six months at ambient condition (24 ± 5°C). The samples were drawn every month and analysed for moisture, peroxide value and free fatty acid.

Sensory evaluation of developed product

The developed BPS vermicelli upma mix was cooked by adding 200 ml water for 100 g of BPS vermicelli upma mix and cooked for 3 minutes and compared with control upma mix. Sensory evaluation was carried out by a panel of 21 semi-trained panel member using 9-point hedonic scale (Rangana, 1986).

Statistical Analysis

Data was analyzed using one-way analysis of variance (ANOVA) and in the randomized complete block design to determine the level of significance at 5%.

RESULTS AND DISCUSSION

TABLE 1

Mean sensory evaluation of different variations of BPS vermicelli upma

Variations	Appearance	Color	Texture	Aroma	Taste	Overallacceptability
Control	8.02±0.18^{ab}	8.12±0.15^{ab}	8.16±0.16^{ab}	8.01±0.10^{ab}	8.06±0.25^{ab}	8.05±0.17^{ab}
T_1	7.05±0.12^{a}	7.20±0.17^{a}	7.00±0.20^{a}	7.12±0.13^{a}	7.17±0.09^{a}	7.10±0.28^{a}
T_2	7.61±0.24^{ab}	7.47±0.12^{ab}	7.54±0.20^{ab}	7.69±0.19^{ab}	7.45±0.22^{ab}	7.55±0.21^{ab}
T_3	7.70±0.11^{b}	7.82±0.19^{b}	7.63±0.14^{b}	7.68±0.17^{ab}	7.54±0.18^{b}	7.75±0.29^{b}
T_4	6.01±0.21^{b}	6.03±0.19^{b}	6.11±0.04^{b}	6.16±0.14^{ab}	6.14±0.25^{b}	6.10±0.14^{b}
F-value	*	*	*	*	*	*
SEm±	0.091	0.095	0.092	0.089	0.09	0.095
CD at5%	0.273	0.285	0.276	0.267	0.27	0.285

*Significantat5%, Values are mean± standard deviation (n=3). Means with different superscripts within the same column are not significantly different ($p < 0.05$). (Control – 80 % SL + 20% WWF, T_1 – 80 % SL + 15% WWF + 5% BPS, T_2- 70 % SL + 20% WWF + 10% BPS, T_3- 60 % SL + 20% WWF + 20% BPS, T_4-60 % SL + 15 % WWF + 25 % BPS). (BPS-Banana pseudo stem, WWF-Whole wheat flour, SL-Semolina)

BPS vermicelli was standardised by incorporating BPS flour. The composite flour blends were prepared by substituting the whole wheat flour and semolina with 5 percent (T_1), 10 percent (T_2), 20 percent (T_3) and 25 percent (T_4) BPS flour and control was prepared without addition of BPS flour. The mean sensory scores of different variation of BPS vermicelli upmais depicted in Table 1. Statistically significant difference was observed with respect to appearance, texture, colour, aroma, taste and overall acceptability. The overall acceptability of T_2 and T_3 was between the moderately acceptable range (7.1 to 7.75) andT_4 was between slightly acceptable range (6.1) because as the percentage of incorporation of BPS flour increases in the vermicelli adversely affected the texture, taste, colour, overall acceptability and also affected cooking and organoleptic properties with increase in solid loss. Hence T_3 was taken for further studies.

Raju *et al.* (2019) determined the Cutlet prepared by banana pseudo stem flour at different level (5,10 and 15 %) with that of the control (without incorporating Banana pseudo stem flour). The results revealed that the appearance scores showed to decreasing trend with increasing the levels BPS flour. And the flavour scores remained constant in all the variation and the texture prevailed in the sample than control due to the addition BPS flour. However, overall acceptability was higher in the sample than control.

Similarly, Shruthi *et al*. (2022) evaluated the sensory characteristics of Bamboo rice shavige mix. Among all the variations highest score was recorded for 50 percent (T_2) bamboo rice shavige and least observed for 75 percent (T_4) bamboo rice shavige. The score for appearance ranged from 7.00 to 7.50, for colour ranged from 6.85 to 7.40, for taste ranged from 6.80 to 7.20, for texture ranged from 6.80 to 7.20 and overall acceptability ranged from 6.85 to 7.45.

TABLE 2

Nutritional Analysis of developed BPS flour-based RTC vermicelli upma mix

Nutrients/100g	**Control**	**T_3**	**t-value**
Moisture	0.72±0.3	1.63±0.15	4.554*
Protein	13.3±1.15	16.2±1.7	3.908*
Total fat	2.2±0.1	1.15±0.02	10.49*
Total ash	22.4±0.1	27.2±0.08	18.40*
Crude fibre	1.04 ±0.02	4.82 ± 0.07	83.52*
Soluble fibre	1.63±0.05	2.64±0.34	5.09*
Insoluble fibre	7.19 ±0.03	15.76±0.05	224.6*
Total dietary fiber	8.82±0.08	18.4±0.39	209.5*
Energy (kcal)	329.4±0.28	310.3±0.32	64.2*
Carbohydrates	64.1±1.0	58.9±0.04	23.80*
Calcium (mg %)	4.59±0.004	5.72±0.004	239.70*
Magnesium (mg %)	0.24±0.004	0.43 ± 0.004	38.89*
Potassium (mg%)	768.3±0.94	1203.6±0.47	584.06*
Phosphorus (mg %)	3.46 ±0.05	5.01 ± 0.005	46.26*

Iron (mg %)	1.04 ± 0.005	1.77 ± 0.004	154.85*
Zinc (mg %)	2.18± 0.02	4.38± 0.04	185.10*
Manganese (mg %)	0.27±0.08	0.41±0.08	105.2*

*Significantat5%, Values are mean±standard deviation (n=3). Control- vermicelli without BPS flour, T_3 – BPS vermicelli (20%)

The nutritional composition of BPS vermicelli upma mix (T_3) and control vermicelli mix is depicted in Table 2. BPS vermicelli has significantly more ash (27.2 g), crude fibre (4.82 g), soluble fiber (2.64 g) and insoluble fiber (15.76 g) which increases the dietary fiber intake of an individual also improves digestive health, controls the diabetes and prevents the risk of colorectal cancer. The high ash content indicates the presence of minerals such as potassium (1202 mg %) and zinc (4.38 mg %) which aids in proper muscular function, acts as a diuretic and helps in detoxifying the body. The above results confirmed control vermicelli claimed to lack these nutrients.

Similar kind of variation in the nutritional composition of different levels of BPS flour incorporated Biscuit and Brownies was reported by Chakraborty *et al*. (2021) and Marivel et al. (2021).

TABLE 3

Phytochemical composition of RTC BPS vermicelli upma mix

Parameters (mg %)	Control	T_3	t-value
Antioxidant activity	1.82±0.005	3.93±0.005	102.4*
Total phenols	459.3±0.26	583.4±0.55	546.8*
Flavonoids	151.3±0.005	165.7±0.11	5.48*
Tannins	2.05±0.005	4.01±0.005	106.2*
Saponins	206.5±0.05	291.06±0.01	2.98*

The phytochemical composition of BPS vermicelli upma mix (T_3) and control vermicelli upma mix is depicted in Table 3. Significantly higher antioxidant activity (3.93 mg), total phenols (583.4 mg GAE %), flavonoids (165.7 mg%), tannins (4.01 mg%) and saponins (291.06 mg%) was noticed. The BPS vermicelli upma mix (T_3) enhanced the phytochemical

contents compared to control vermicelli upma mix which is often associate with increase in the free radical scavenging properties.

Similarly, Chakraborty *et al.* (2021) observed increments in antioxidant molecules and free radical scavenging properties of the BPS flour substituted wheat flour biscuits.

TABLE 4

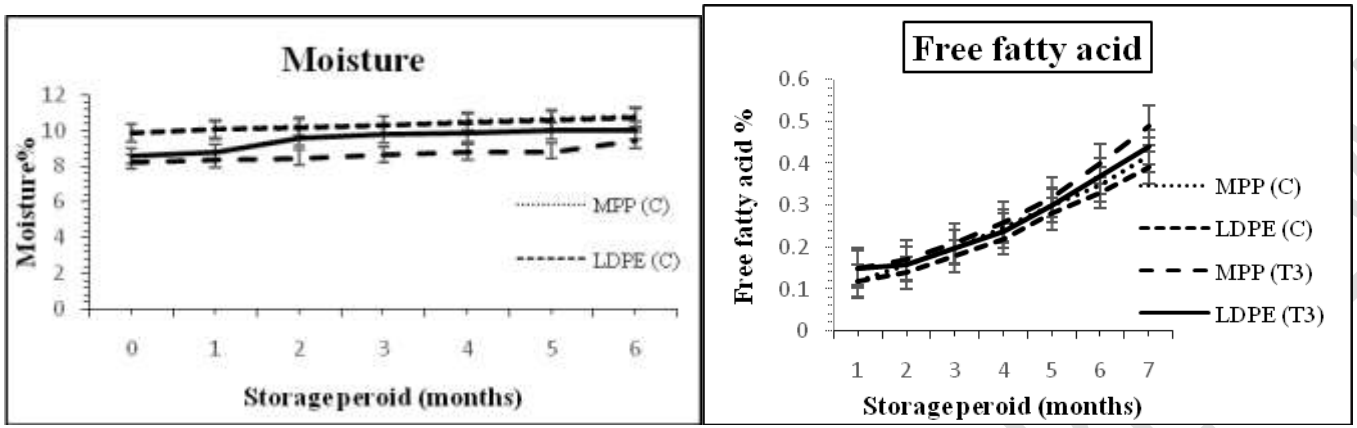
Cooking characteristics of BPS vermicelli

Variations	Cooking time (min)	Swelling power (g/g)	Solid loss (%)
Control	5.16	0.99	1.12
T_1	2.04	0.36	1.25
T_2	2.40	0.69	1.31
T_3	2.52	1.22	1.35
T_4	2.55	1.30	1.59

(Control – 80 % SL + 20% WWF, T_1 – 80 % SL + 15% WWF + 5% BPS, T_2- 70 % SL + 20% WWF + 10% BPS, T_3- 60 % SL + 20% WWF + 20% BPS, T_4-60 % SL + 15 % WWF + 25 % BPS). (BPS-Banana pseudo stem, WWF-Whole wheat flour, SL- Semolina)

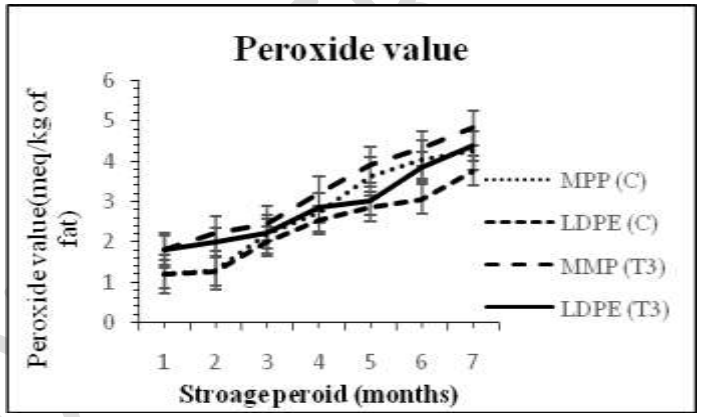
Cooking characteristics of developed BPS vermicelli and control vermicelli is depicted in Table 4. The results obtained were significantly different from each other. The maximum cooking time was observed in T_4(2 minutes 55 seconds) and minimum was T_2 (2 minutes) compared to control (5 minutes). The maximum swelling power was observed in T_4 (1.30 g/g) and minimum was T_2(0.36g/g) compared to control (0.99 g/g). Swelling power is high in T_4 due to high ratio of BPS flour which is rich in dietary fiber tend to absorb more water leading to increase the swelling ratio.The swelling power was determined as Schoch (1964). The solid loss was maximum in T_4(1.59%) and minimumT_1(1.25%) compared to Control (1.12%). Hence, from the above observations T_3 variation was taken for further studies due its nutritional value with good cooking characteristics. This observation was by the method prescribed by Jalgaonkar *et al*. (2019).

Similar variation in cooked weight and cooking time for different variations of BPS vermicelli was reported by Midha and Mogra (2007). Variation in cooking time was well documented by Kaur et al. (2012) for cereal bran-enriched pasta.



(a)

(b)



(c)

MMP (C): Control vermicelli upma mix in MPP, LDPE (C): Control vermicelli upma mix in LDPE,

MPP(T_3): BPS vermicelli upma mix in MPP, LDPE (T_3): BPS vermicelli mix in LDPE.

Fig.1: Effect of storage on (a) moisture (%), (b)free fatty acids (%) and (c)peroxide value (meq/Kg of fat) of BPS vermicelli upma mi

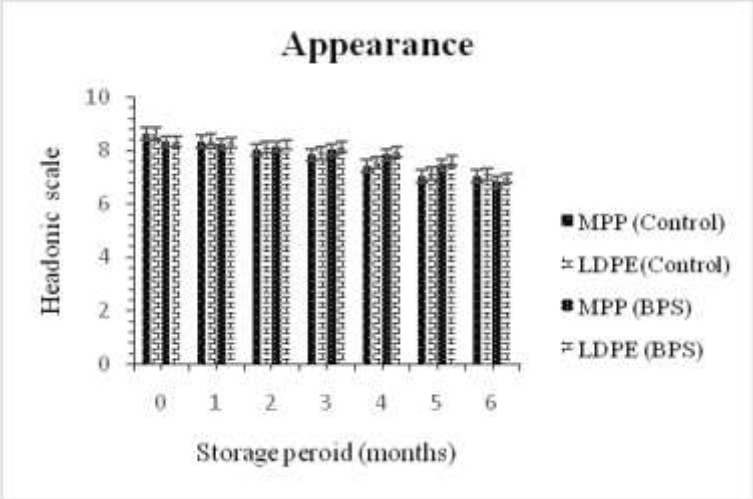
Effect of storage on moisture (%), free fatty acids (%) and peroxide value (meq/Kg of fat) of BPS vermicelli upma mix

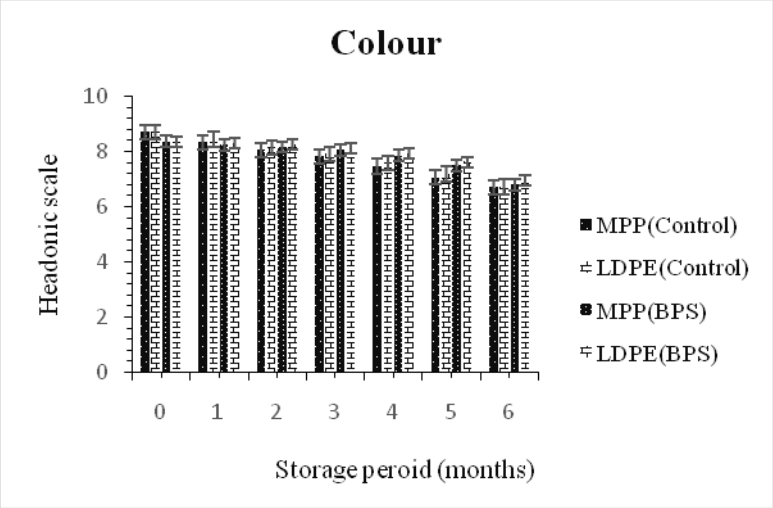
The changes in the moisture, free fatty acid and peroxide value of the control vermicelli upma mix and BPS vermicelli upma mix (T_3) are depicted in Table 4. Increase in moisture content of vermicelli upma mixes in two types of packaging materials (MPP and LDPE) over six months of storage period was noticed. The results of Fig.1(a)indicated that, a significant difference was noticed concerning changes in moisture content in two types of packaging material and two products. Moisture content values were significantly similar in both pouches in control upma mix and BPS vermicelli upma mix because these pouches serve as better moisture and oxygen barrier.

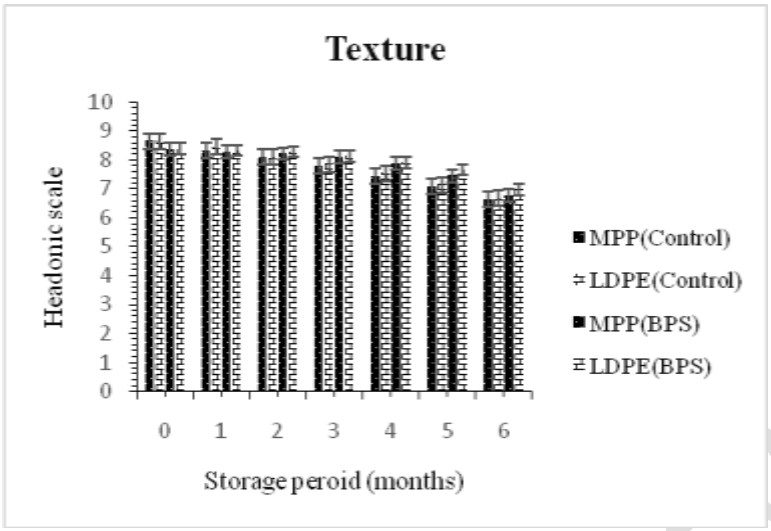
The FFA content of control and BPS vermicelli upma mix were slightly increased with increase in storage period fig.1(b). However, values remained in the acceptable range. FFA values were significantly high in MPP pouch compared to LDPE pouch both in control and BPS vermicelli upma mix. At the end of the storage period, control upma mix with LDPE and MPP packaging had 0.44 and 0.39 respectively and for BPS vermicelli upma mix with LDPE and MPP packaging had 0.49 and 0.44 respectively. Analysis of data showed that interaction of treatments and packaging, treatments and duration, packaging and duration have a significant impact on FFA of vermicelli upma mixes ($p<0.05$). However, overall interaction between the treatments, packaging material and duration over six months of storage period was non-significant. Similar results were observed by Shobha *et al.* (2015) during storage of maize based composite flour noodles.

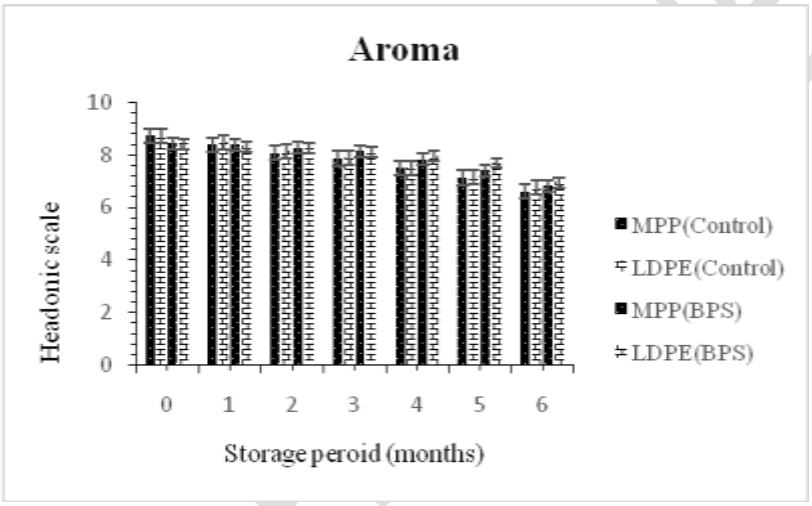
Peroxide value of control and BPS vermicelli upma mixes stored in two types of packages (LDPE and MPP) is presented in Fig.1(c). In control vermicelli upma mix, peroxide value in MPP pouch increased significantly from 1.2 to 4.26, while in LDPE pouch it increased from 1.2 to 3.76. In T_3 BPS vermicelli upma mix it was increased from 1.8 to 4.82 in MPP pouch and from 1.8 to 4.38 in LDPE stored sample. A significant difference was not observed between the products, duration and between the treatments and packaging materials over the six months storage period. Peroxide values were within the safe limits up to 6 months of storage period as per BIS limits (BIS, 2006). However, control vermicelli upma mix had less value for peroxides compared to the BPS vermicelli upma mix(T_3). According to Kirk & Sawyer (1991) for a noticeable rancidity the peroxide value of 20-40 meq/kg as the range at which rancidity begins.

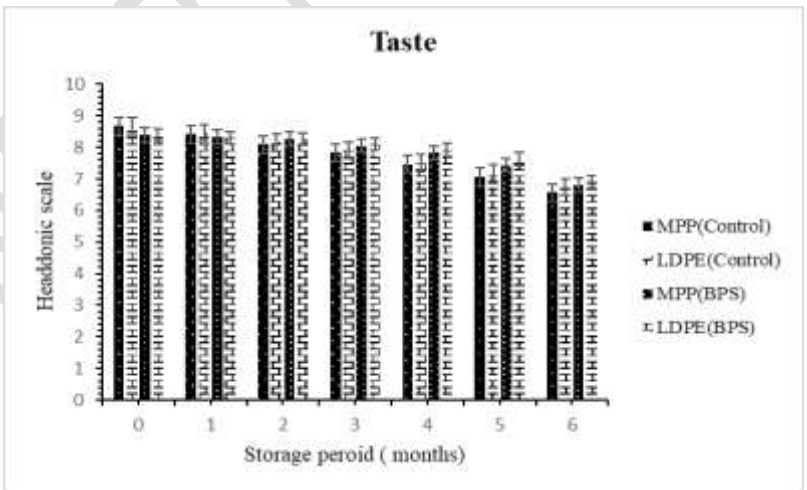
Similar trend was noticed by Balasubramanian *et al.* (2014) during the storage of Pearl millet based upma dry mix. During the storage period of six months there was slight increase in peroxide value gradually after 2 months was 2.5±0.05 to 17.6±0.20 meqO_2 kg/fat and FFA value was 0.27±0.021 to 0.56±0.042%.

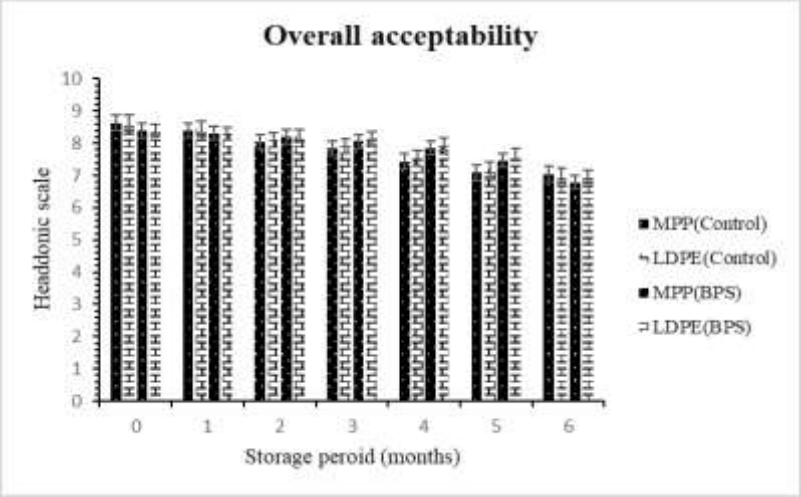





Texture
Headonic scale
10
9
8
7
6
5
4
3
2
1
0
0 1 2 3 4 5 6
Storage peroid (months)
MPP(Control)
LDPE(Control)
MPP(BPS)
LDPE(BPS)


Aroma
Headonic scale
10
8
6
4
2
0
0 1 2 3 4 5 6
Storage peroid (months)
MPP(Control)
LDPE(Control)
MPP(BPS)
LDPE(BPS)


Taste
Headonic scale
10
9
8
7
6
5
4
3
2
1
0
0 1 2 3 4 5 6
Storage peroid (months)
MPP(Control)
LDPE(Control)
MPP(BPS)
LDPE(BPS)



MMP (Control): Control vermicelli upma mix, LDPE (Control): Control vermicelli upma mix, MPP(BPS): BPS vermicelli upma mix in MPP, LDPE (BPS): BPS vermicelli upma mix in LDPE.

Fig.2: Effect of storage on sensory scores of BPS vermicelli upma mix during storage

Effect of storage on sensory scores of BPS vermicelli upma mix during storage

The appearance, colour, texture, taste and flavour are the important characteristics for acceptability and these are the good indicators for physiochemical changes during storage Rao *et al*. (1995). The mean sensory scores of BPS vermicelli upma mixes during six months storage period are depicted in Table 4. The sensory scores were found to be significantly more for control compared to BPS flour incorporated vermicelli upma mix (T3). After one month of storage period, control vermicelli upma mix score decreased significantly compared to the BPS vermicelli upma mix. Further, as the month of storage increased, the scores for all the sensory attributes were decreased significantly in both the samples. Analysis of variance indicated a non-significant difference between the treatments, packaging materials and duration over six months of storage period on overall acceptability of BPS vermicelli upma mix at 5% level. The overall acceptability scores were observed up to 6 months of storage in both packaging materials. There was slight decrease in the sensory scores of both the samples with an increase in the storage days may be due to the decline colour and taste in the product. At the end of storage period, both control and BPS vermicelli upma mix stored in MPP retained significantly higher sensory scores. Though there were slight changes observed in all sensory attributes, the products were stable up to 6 months due to the dehydration process, which increased the quality of the products. The decrease in sensory scores of the stored

product at different temperatures was reported by Brundha *et al*. (2022). A similar line of work on storage studies on maize flour incorporated vermicelli by Shobha *et al.* (2015).

Conclusion

From the study, it can be concluded that RTC vermicelli upma mix prepared with incorporation of BPS flour at 20 percent (T_3) level was best accepted in terms of nutritional quality such as dietary fiber, ash, potassium, calcium, magnesium, iron along with bioactive compounds such as polyphenols, tannins, saponins and flavonoids which contribute for enhanced antioxidant capacity compared to the control. Stored vermicelli upma mix in MPP pouches showed better retention of bioactive compounds, and sensory and physiochemical parameters under ambient conditions (25 ± 5^0C). Hence, the RTC vermicelli upma mix can be stored up to six months under ambient temperature.

Acknowledgment: Authors are gratefully acknowledged the financial support of UAS (B) under the project entitled "Development of immunity boosting value added products from Centella leaves and Banana pseudo stem".

Disclaimer (Artificial Intelligence): Author(s) hereby declare that NO generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

REFERENCES

AHMAD, T. & DANISH, M.,2018, "Prospects of banana waste utilization in wastewater treatment. A review" J. environ manage, 206, pp. 330-348.

AOAC, 2005, Official Methods of Analysis, Association of official analytical chemists, 18thed.Washington, D.C., USA, 2-38.

AOAC., 2000, Official Methods of Analysis, 17th ed. Washington, D. C., USA.

AZIA, N. A. A., Ho, L. H., AZAHARI, B., BHAT, R., CHENG, L. H., & IBRAHIM, M. N. M,2011, "Chemical and functional properties of the native banana (Musa acuminata× balbisianaColla cv. Awak) pseudostem and pseudostem tender core flours", Food Chemistry, 128(3): 748-753.

BALASUBRAMANIAN, S., YADAV, D.N., KAUR, J., & ANAND, T, 2014, Development and shelf-life evaluation of pearl millet based upma dry mix. J. Food Sci. Technol, 51, 1110-1117.

BHASKAR, J. J., MAHADEVAMMA, S., CHILKUNDA, N. D. AND SALIMATH, P. V., 2011, Banana (musa sp. Var. elakkibale) flower and pseudostem: dietary fiber and associated antioxidant capacity. J. Agril. Food Chem., 60(1): 427-432.

BRUNDHA AR, SHOBHA D, DEVAKI CS AND SHEKHARA NAIK R, 2022, Nutritional, functional and shelf-life studies of RTC little millet bisibelebath mix, The Pharma Innovation,11(3),476-484.

BUREAU OF INDIAN STANDARDS, 2006, IS:2639. Specification for population. New Delhi: Bureau of Indian Standards.

BUVANESHWARI, K., G. SASHIDEVI, G. HEMALATHA, AND R. ARUNKUMAR. 2020. "Development and Quality Evaluation of Ready to Serve (RTS) Beverage from Banana Pseudo Stem". *European Journal of Nutrition & Food Safety* 12 (9):32-42. https://doi.org/10.9734/ejnfs/2020/v12i930281.

CHAKRABORTY AND RAKHI,2021, Banana pseudo stem substitution in wheat flour biscuits enriches the nutritional and antioxidant properties with considerable acceptability.SN Applied Sci.

GO, MARIVEL B, 2021, Effect of incorporation of Banana pseudo stem flour at different proportions on the Sensory properties, proximate and mineral composition and Microbial quality of baked Brownies. Food Sci.Tecnol,87-95.

HAI, W., CHENG, H., ZHAO, M., WANG, Y. I., HONG, L., TANG, H., AND TIAN, X., 2012, Two new cytoxictriterpenoidsaponins from the roots of Clematis argentilucida. Fitoterapia, 83: 759-764.

JALGAONKAR AND KIRTI, 2019, Pearl millet-based pasta optimization of extrusion process through response surface methodology, J. Food Sci. Technol.,56(3),1134-1144.

JOSHI, H., AND AWASTHI, P., 2022, Phytochemical analysis of Giloy stem powder and sensory Analysis of GiloyTinosporacordifolia stem powder incorporated sweet balls. The Pharma innov. j., 11(5): pp. 1563-1567.

KADDUMUKKASA, P., KYAMUHANGIRE, W., MUYONGA, J. and MURANGA, F. I, ,2005. The effect of drying methods on the quality of green banana flour. African Crop Science Conference Proc.7:1267-1271.

KARUNA, T. D., AND P. NAZNI,2018, Formulation, texture and sensory

characteristics of little millet based RTC (ready-to-cook) soup mix, Int J. Food Sci Nutri., 3(2),187-191.

KAUR G, SHARMA S, NAGI HPS, BASHARAT N, DAR,2012, Functional properties of pasta enriched with variable cereal brans. J. Food Sci Technol.,49(4),467-474.

KIRIK RS, SAWYER R.,1991, Addison Wesley Longman Ltd., England, Pearson's composition and analysis of Foods.,29(9),608-640.

LAKSHMAN, R., AMBROSE, D. C., & CHELVAME, D, 2015, Studies on the quality of banana center core flour prepared by different drying methods. Curr Agric. Res.J., 3(1):55-59.

MOHAPATRA, D., SABHYASACHI M., and NAMRATA S,2010, Banana and its by-product utilization: an overview." J. of Sci & Ind Res.,69, 323-329.

NEOG, S. R., & DEKA, C. D,2013, Salt substitute from banana plant (Musa BalbicianaColla). J. on Chem and Pharmaceutical Res, 5(6), 155-159.

ONIVOGUI G, ZHANG H, MLYUKA E, DIABY M, SONG Y,2014, Chemical Composition, Nutritional Properties and Antioxidant Properties of Monkey Apple (Anisophyllea laurina R. Br. Ex Sabine), J. Food Nutri.,2(6),281-287.

ONIVOGUI, G., ZHANG, H., MLYUKA, E., DIABY, M., AND SONG, Y., 2014, Chemical composition, nutritional properties and antioxidant activity of monkey apple (Anisophyllea laurina R. Br. Ex Sabine). J. Food Nutr. Res., 2(6): 281-287.

RAJU, S.K., PHILOMENA JOY LINDSEY, A. AND EMILIN RENITTA.R, 2019, Shelf-life assessment of Banana pseudo stem cutlet, Int J. of Eng. Advanced technol., 8 (6), 210-214.

RANGANNA, S., 1986, Hand book of analysis and quality control for fruits and vegetable products, 2nd ed. Tata McGraw-Hill publishing company limited, New Delhi.

RAO STS, RAMAYANA MN, ASHOK N, VIBHAKAR HS, 1995, Storage properties of wheat egg powder incorporated biscuits, J Food Sci Technol.,32,470-476.

SCHOCH, TJ,1964, Sweeling Power and Solubility of Granulea starches. Methods of Carbohydrate Chemistry.,4,106-108.

SHOBHA D, VIJAYLAKSHMI D, PUTRAMANAIK AND ASHA K.J, 2015,

Evaluation of maize flour incorporated vermicelli for nutritional, sensory and storage quality, J. Food Sci. Technol.52(11),7173-7181.

SINGH, R., KAUSHIK, R., & GOSEWADE.S,2018, Bananas as underutilized fruit having huge potential as raw materials for food and non-food processing industries: A brief review- The Pharma Innov. J., 7 (6),574-580