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Development and Evaluation of Value-Added, Ready to Cook Noodles Using Millet Flour, Moringa Leaves Powder and Raw Banana Flour

Bhoomika A[1], Navaneetha R[2]

[1]M.Sc. Research Student, Department of Food and Nutrition, Smt. VHD Central Institute of Home Science, School of Home Science, Maharani Cluster University, Bengaluru – 560 001
[2]Associate Professor, Department of Food and Nutrition, Smt. VHD Central Institute of Home Science School of Home Science, Maharani Cluster University, Bengaluru – 560 001

Abstract
There is an increase in the demand for healthy and easy to cook foods among the present-day consumers. Noodles is a popular staple food in many countries because they are fast and easy to cook which appeals to both urban and rural consumers. This study is aimed at developing a value added ready-to-cook noodles using millet flours (Bajra and Jowar) as the main ingredients. Functional ingredients included moringa leaves powder (good source of micronutrients, antioxidants), raw banana flour (good source of resistant starch) and dehydrated vegetables (Carrot and Beans). Value added, ready to cook noodles were prepared from a combination of Jowar flour, Bajra flour, Raw banana flour, Moringa leaves and a Minimal quantity of Refined wheat flour. Three different variations V1, V2, V3 were developed along with noodles made with refined wheat flour (basic). All the three different variations along with basic was subjected to sensory evaluation using 9-point hedonic rating scale by 45 semi trained panelists. The results of sensory evaluation showed that value added noodles (V1) was best accepted among other variations. The best accepted value-added noodles were evaluated for nutrient content and shelf life. This study shows that by incorporating millets, moringa leaves and raw banana flour there is an enhancement in the nutritional value of a popular and convenient, food choice like noodles.

Keywords: Value addition, millet flour, moringa leaves powder, raw banana flour, sensory evaluation.

1. Introduction

Noodles form part of everyday diet in many countries especially in Asia like Japan, Korea, China etc. India is one among the countries where the consumption of noodles is on the rise. Noodles are generally made from refined wheat flour (Maida). Common steps in noodle production involve dough kneading, conditioning, sheeting and compounding, cutting, steaming and drying (M Udhaya ganga et al, 2019). With the increase of awareness among health-conscious consumers there is an increase in the demand for healthy food products. Maida, which is a refined by product of wheat flour, comes with a serious health consequence. It's good taste, high stretch ability, extensibility along with high shelf-life has greatly contributed to its popularity and marketability. Maida poses a serious threat to human health and is often referred to as 'glue of the gut', as it turns into ‘glue’ in the intestines. Maida lacks fiber and is high in calorie content leading to various health issues like weight gain, stress, headaches and migraines. Reduced

usage of maida can greatly decrease the incidence of various physiological and psychological diseases which are associated with increased usage of Maida (S Ganga et al, 2020). The value-added, ready to cook millet noodles were developed using millets (jowar flour, bajra flour), moringa leaves powder, raw banana flour and dehydrated vegetables using minimal quantity of Maida flour.

Food extrusion is a process in which desired food ingredients are mixed and passed under pressure. Ingredients such as maize, soy, wheat, sorghum and many others are processed by mixing, heat application and Shearing. The processed food product is later passed under pressure through a perforated plate or die in to a desired shape which will appeal to the consumers. The combination of preparing the desired food product and extruding it through desired shape is called as food extrusion (Abdulkadir et al, 2019).

The year 2023 is considered as INTERNATIONAL YEAR OF MILLETS. Millets form a significant part of Indian diet and are grown widely in India. Millets are also called nutri cereals because of their high nutrient contents and they can be used as a substitute for wheat products especially in people with gluten allergy. In recent years, millet noodles have become increasingly popular as a healthier alternative to traditional wheat noodles (Pradeep et al, 2023). Sorghum is also known as Jowar and universally is the traditional staple food of dry land regions and worldwide India ranks fourth in the jowar production. Sorghum (Jowar) contains a good source of calcium, phosphorus, potassium with sufficient amounts of iron, zinc and sodium and has been used as means to reduce malnutrition globally. Pearl millet also known as Bajra is widely distributed across the semiarid tropics of Africa and Asia (Millet recipe, 2021). Bioactive chemicals in sorghum grains enhance the gut microbiota and exhibit a wide range of biological activities, including anti-inflammatory, antioxidant, antithrombotic, and antidiabetic qualities (Heba Mohamed et al, 2022). In India, pearl millet is primary source of dietary energy (360 kcal/kg) for rural population in drier parts of the country and 4th most important cereal after rice, wheat and sorghum. It is a rich source of protein, calcium, phosphorous and iron. Pearl millet grain contains fairly high amount of thiamine, riboflavin and niacin (Vikas Gupta et al, 2022). It has high levels of protein with better amino acid balance than other major cereals such as rice, wheat and maize (MG Phalphale et al, 2021).

Moringa oleifera, also known as the drumstick tree, is a Moringaceae family member and is also known as the "Miracle Tree." (Mahato DK et al, 2022). Drumstick leaves have many health benefits and Ayurveda states that the leaves of the Moringa tree can prevent up to 300 diseases (Kakde SB et al, 2018). Moringa is rich in nutrition owing to the presence of a variety of essential phytochemicals present in its leaves, pods, and seeds (Zahidul Islam et al, 2021). Even after drying, moringa leaf powder is an excellent source of vitamin C and minerals like calcium and iron which are essential for bone health and blood formation. The functional properties of moringa powder like foaming capacity and foaming stability make it an excellent value addition in several bakery foods (Subhadra Mandalika et al, 2023).

Raw banana flour is prepared from the raw bananas and is widely used in preparing pastries and cookies. Unripe banana flour contains good amount of fibre, micronutrients and resistant starch. Resistant starch is a nondigestible fiber that ferments in the large intestine, and consumption of it has shown to have a positive effect on metabolism in animal studies (Food, Nutrition and Safety Magazine, Dec, 2023). Resistant starch is shown to control weight and can be beneficial in preventing overweight and obesity. Resistant starch improves in the expansion of extruded cereals and snacks and its resistant starch has physiological and physicochemical properties such as swelling, viscosity, gel formation and water binding (Shashank Bhalkar, 2023) which makes it a good choice in food processing.

Dehydrated vegetables – beans and carrots were added to the developed value-added noodles to increase the micronutrient density.

The present investigation was undertaken with the objective of developing a value-added, ready to cook noodles using Millet flour (Jowar flour and Bajra flour), Moringa leaves powder and Raw banana flour. The value added ready to cook noodles were evaluated for sensory characteristics, nutrient contents and shelf life.

2. Materials and Methods

The raw materials required for the development of value added, ready to cook noodles like jowar flour, bajra flour, refined wheat flour, raw banana, moringa leaves and other ingredients were procured from a local super market.

2.1 Preparation of Moringa leaves powder

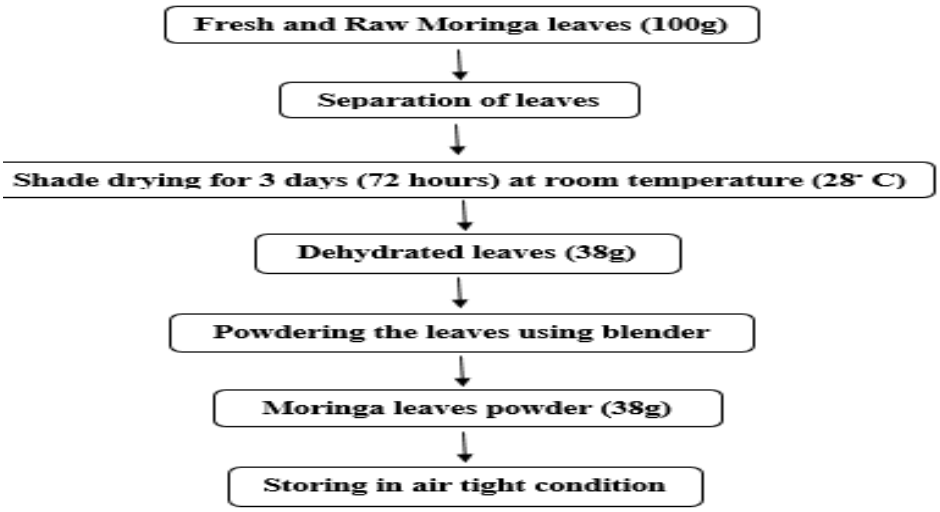

Figure 1: Preparation of moringa leaves powder

2.2 Preparation of Raw banana flour

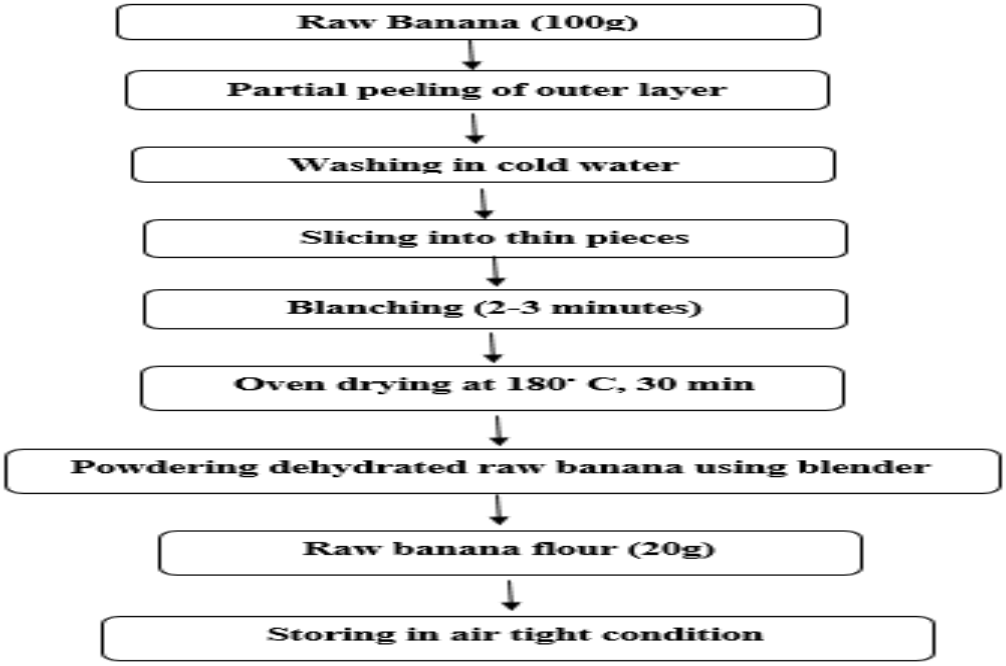

Figure 2: Preparation of raw banana flour

2.3 Preparation of Dehydrated Vegetables

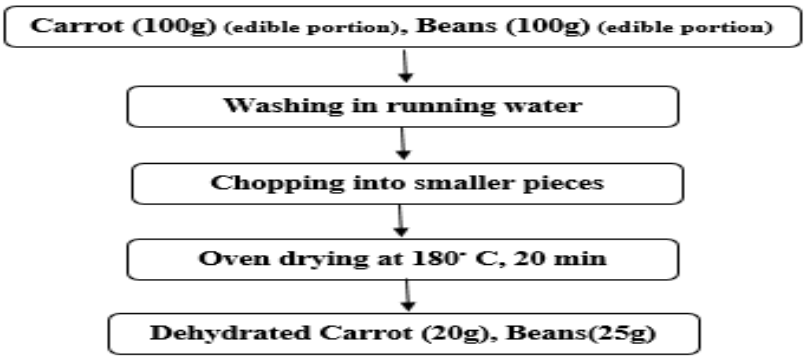

Figure 3: Preparation of dehydrated vegetables

2.4 Preparation of Sprinkler (Seasoning)

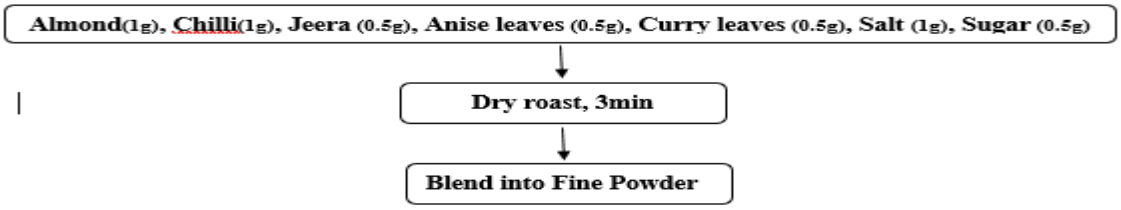

Figure 4: Preparation of sprinkler (seasoning)

2.5 Development of Value added, Ready to cook Noodles

Experimental method was adopted in developing value added, ready to cook noodles. Several preliminary experimental trials were carried out in the development process. Three variations of value added, ready to cook noodles were developed along with noodles made from refined wheat flour (basic). Three variations were developed with the varying proportion of moringa leaves powder. V1 with 5% of moringa leaves powder, V2 with 10% of moringa leaves powder and V3 with 15% of moringa leaves powder.

All the dry ingredients mentioned in Table 1, were mixed thoroughly and kneaded into soft dough using hot water and rested for 5 minutes, Noodles were extruded using the manual domestic extruder. The extruded noodles were steamed for 20 minutes, sundried for 12 hours and stored under air tight conditions.

2.6 Sensory Evaluation

Sensory evaluation was carried out by 45 semi -trained panel members to study the acceptability of the basic and variations of value added, ready to cook noodles using the 9 Point Hedonic scale of rating. Various attributes such as Appearance, Color, Consistency, Flavour, Taste, Overall acceptability were rated on the scale from 1-9. 1 being the lowest score and 9 being the highest. Score 1 means dislike extremely and score 9 means like extremely. The scores were statistically evaluated. Mean, ANOVA test, post hoc comparison, Standard deviation were calculated and results were drawn. The best accepted variation of value-added, ready to cook noodles was used to further study the nutrient composition and shelf life.

The developed value added, ready to cook noodles was prepared by boiling them for 2 minutes with required amount of water. The boiled value-added noodles were seasoned with a freshly made sprinkler and was served hot in equal quantities to the semi trained panellists to evaluate the sensory characteristics.

2.7 Nutrient composition

Energy, Carbohydrates Protein, Fiber, for edible portion of raw ingredients, used in development of best accepted value-added noodles, ready to cook noodles was calculated by computation method using Indian Food Composition Table, ICMR, 2017

The best accepted value added, ready to cook noodles (Variation 1) was subjected to micronutrient analysis (Calcium, Iron, Zinc) at Robust materials technology PVT. Ltd., (NABL -Accredited, Drugs Control Department – Approved, FSSAI, ISO 45001:2018 Certified) Bengaluru.

2.8 Shelf life Study

The shelf-life study of the value-added, ready to cook noodles was conducted at room temperature. The value-added noodles were stored under air tight condition using food grade high density polythene bags.

3. Results and Discussion

Table 1: Ingredients used for the preparation basic and variations of value added, ready to cook noodles

Ingredients	**Variations**			
	BASIC	**VARIATION 1**	**VARIATION 2**	**VARIATION 3**
Refined wheat flour	95%	20%	15%	10%
Jowar Flour (***Sorghum vulgare***)	-	25%	25%	25%
Bajra Flour (***Pennisetum glaucum***)	-	25%	25%	25%
Raw Banana flour (***Musa acuminate***)	-	10%	10%	10%
Dehydrated vegetables (carrot, beans)	-	10%	10%	10%
Moringa leaves powder (***Moringa oleifera***)	-	**5%**	**10%**	**15%**
Sprinkler (Seasoning)*	5%	5%	5%	5%
Salt	To taste	To taste	To taste	To taste

Ingredients for sprinkler: Almond(1g), Chili(1g), Jeera (0.5g), Anise leaves (0.5g), Curry leaves (0.5g), Salt (1g), Sugar (0.5g)

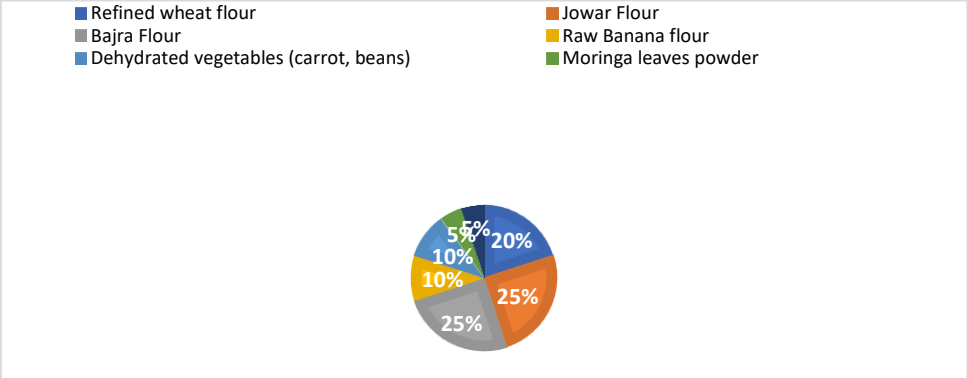

Figure 5: Ingredient composition of value added, ready to cook noodles (V1-Best accepted variation)

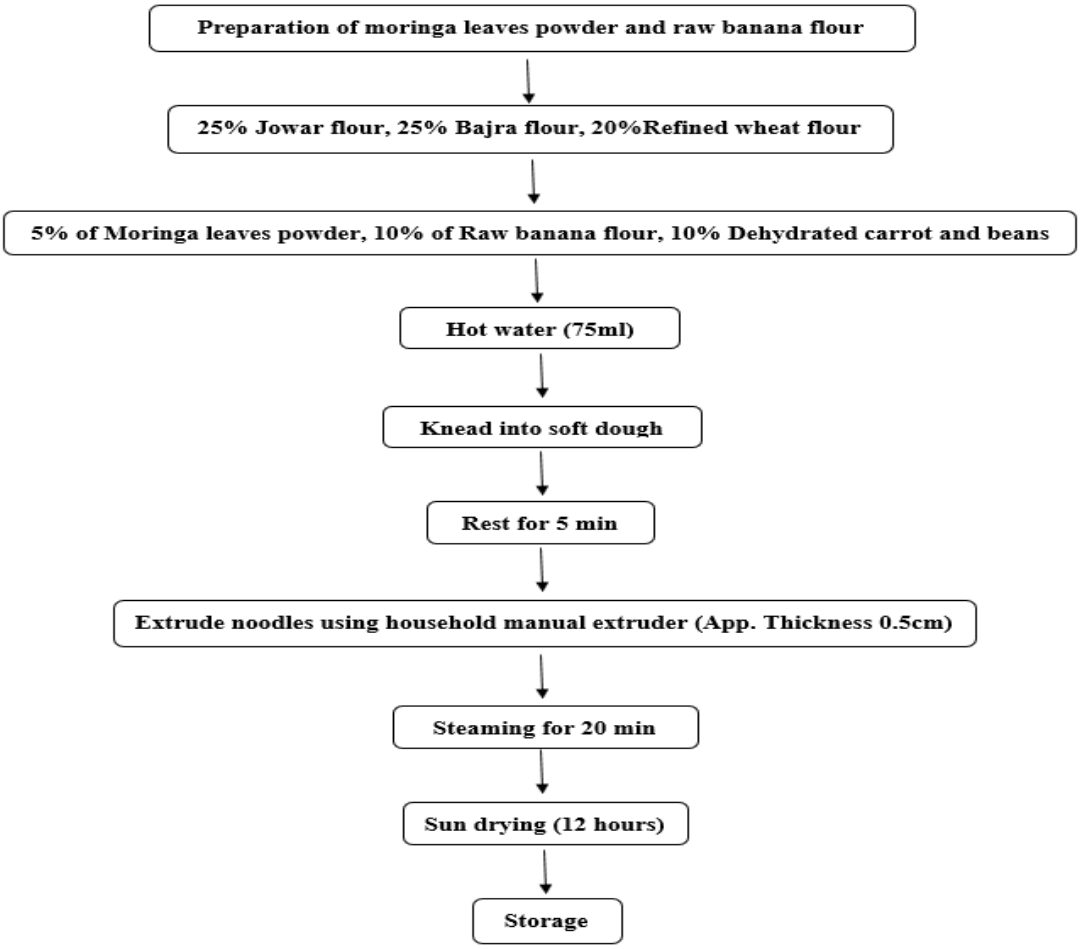

Figure 6: Development of value added, ready to cook noodles (V1-Best accepted variation)

Table 2: Sensory scores of basic and variations of value added, ready to cook noodles

Sensory characteristics	Noodles	**Mean**	**Std. Deviation**	**F-value**	**P-value**	**Post Hoc Comparison**
APPEARANCE	Basic	7.9	1.103	2.6514	0.0502	N/A
	Variation 1	7.9	0.930			
	Variation 2	7.4	1.164			
	Variation 3	7.6	1.036			
COLOUR	Basic	8.1	1.060	3.3089	0.0214	0.00451#
	Variation 1	7.7	1.113			0.00869$
	Variation 2	7.4	1.204			
	Variation 3	7.5	1.085			

TASTE	Basic	8.1	0.850	6.6299	0.00028	0.0038[@]
	Variation 1	7.4	1.327			0.00026[$]
	Variation 2	7.1	1.275			
	Variation 3	7.4	1.043			
FLAVOUR	Basic	8.2	0.777	6.8476	0.00021	0.00032[$]
	Variation 1	7.8	1.045			
	Variation 2	7.3	1.028			
	Variation 3	7.3	1.366			
TEXTURE	Basic	7.6	1.595	1.7436	0.1598	N/A
	Variation 1	7.5	1.275			
	Variation 2	7	1.406			
	Variation 3	7.2	1.451			
OVERALL ACCEPTABILITY	Basic	7.9	1.085	4.5997	0.0039	0.00079[#]
	Variation 1	7.7	1.062			
	Variation 2	7.1	1.240			
	Variation 3	7.4	1.087			

Note: @Basic v/s Variation 1, #Basic v/s Variation 2, $Basic v/s Variation 3, N/A: Not significant

Basic – Refined wheat flour (95%) + Sprinkler (Seasoning) (5%)

Variation 1 – Jowar flour (25%) + bajra flour (25%) + Refined wheat flour (20%) + Raw banana flour (10%) + Dehydrated vegetables (carrot, beans) (10%) + Sprinkler (Seasoning) (5%) + **Moringa leaves powder (5%).**

Variation 2 – Jowar flour (25%) + bajra flour (25%) + Refined wheat flour (15%) + Raw banana flour (10%) + Dehydrated vegetables (carrot, beans) (10%) + Sprinkler (Seasoning) (5%) + **Moringa leaves powder (10%).**

Variation 3 – Jowar flour (25%) + bajra flour (25%) + Refined wheat flour (10%) + Raw banana flour (10%) + Dehydrated vegetables (carrot, beans) (10%) + Sprinkler (Seasoning) (5%) + **Moringa leaves powder (15%).**

The statistical analysis of different variations revealed that the Variation-01 (Jowar flour (25%) + bajra flour (25%) + Refined wheat flour (20%) + Raw banana flour (10%) + Dehydrated vegetables (carrot, beans) (10%) + Sprinkler (Seasoning) (5%) + **Moringa leaves powder (5%))** was best accepted with the mean scores of 7.7 and was as good on par comparison with basic noodles 7.9 in terms of overall

acceptability. The mean score of variation - 01 for different sensory attributes ranged from 7.9 – 7.4. The highest mean score was for appearance (7.9) and lowest mean score was for taste (7.4).

There was **no significant difference** in the mean scores of "**APPEARANCE**" with respect to different variations **(P > 0.05)**.

There was a **significant difference** in the mean scores of "**COLOUR**" with respect to different variations having the P value of 0.0214 and F value of 3.3089. Post hoc comparison test using Bonferroni method was done at alpha level of 0.05 to find out the significant difference between Basic and different variations. Post hoc test revealed that there was a significant difference between **Basic v/s Variation 2 (P value = 0.00451) and Basic v/s Variation 3 (P value = 0.00869).**

There was a **significant difference** in the mean scores of **"TASTE"** with respect to different variations having the P value of 0.00028 and F value of 6.6299. Post hoc comparison test using Bonferroni method was done at alpha level of 0.05 to find out the significant difference between Basic and different variations. **Post hoc test revealed that there was a significant difference between Basic v/s Variation 1 (P value =0.0038) and Basic v/s Variation 3 (P value = 0.00026).**

There was a **significant difference** in the mean scores of "**FLAVOUR**" with respect to different variations having the P value of 0.00021 and F value of 6.8476. Post hoc comparison test using Bonferroni method was done at alpha level of 0.05 to find out the significant difference between Basic and different variations. **Post hoc test revealed that there was a significant difference between Basic v/s Variation 3 (P value = 0.00032).**

There was **no significant difference** in the mean scores of "**TEXTURE**" with respect to different variations **(P > 0.05).**

There was **a significant difference** in the mean scores of "**OVERALL ACCEPTABILITY**" with respect to different variations having the P value of 0.0039 and F value of 4.5997. Post hoc comparison test using Bonferroni method was done at alpha level of 0.05 to find out the significant difference between Basic and different variations. **Post hoc test revealed that there was a significant difference between Basic v/s Variation 2 (P value = 0.00079).**

Table 3: Nutritional Analysis of value added, ready to cook noodles (V1-Best accepted variation)

Nutrients	Value per 100g
Iron	4.83mg
Calcium	147.4mg
Zinc	2.19mg

The nutritional content of the value-added ready-to-cook noodles is as follows per 100 grams: Energy - 356.12 kcal, Carbohydrates - 63.12g, Protein - 11.02g, Fiber - 12.37g. (Indian Food Composition Table, ICMR, 2017).

Proximate analysis of micronutrients showed, the noodles contribute approximately to 17.7% of the Recommended Dietary Allowance (RDA) for Iron, 10.3% for Calcium, and 9 % for Zinc for an average adult man with a daily calorie intake of 2000kcal. A single serving of these value-added noodles (70g) would provide the above daily requirements.

Table 4: Shelf life Study of value added, ready to cook noodles (V1-Best accepted variation)

Sl.no	Sensory attributes	10 days	50 days	80 days	85 days	After 85 days
01.	Appearance	Soft, glossy Good	Soft, glossy Good	Glossy Good	Slight changes in appearance Not acceptable	There was development of undesirable change in sensory properties, unfit for human consumption, the study was discontinued
02.	Colour	Brownish green, Acceptable	Brownish green, Acceptable	Brownish Green, Acceptable	Dark Brown Not acceptable	
03.	Taste	Good Acceptable	Good Acceptable	Good Acceptable	Change in taste Not acceptable	
04.	Odor	Desirable	Desirable	Desirable	Change in odor Not acceptable	
05.	Texture	Uniform Soft texture, (Easy to chew). Enjoyable	Uniform Soft, (Easy to chew), Enjoyable	Soft (Chewable) Palatable	Hard (Rubbery) Difficult to chew Not Acceptable	
06.	Overall acceptability	Good Palatability, Acceptable.	Good Palatability, Acceptable.	Palatable, Acceptable	Poor palatability Not acceptable	

The above table provides a comprehensive overview of the sensory attributes of value added, ready to cook noodles. Initially, the value added, ready to cook noodles were visually appealing, with acceptable color, good taste, desirable odor, and enjoyable texture. However, by day 85, significant deterioration occurred. There were slight changes in appearance, colour changed from brownish green to dark brown colour. Unacceptable changes occurred in taste and odor. The texture became hard and was difficult to chew. The study was discontinued after 85 days, as the value added, ready to cook noodles were unsuitable for human consumption.

Conclusion

The results of this investigation show that, value addition of noodles with locally available indigenous ingredients like millets, moringa leaves powder and raw banana flour increased the micro nutrients like iron, calcium and zinc. All the three different variations of the value added ready to cook noodles were acceptable, V1 with 5% of moringa leaves powder was best accepted by the semi trained sensory panelists

with the **mean scores of 7.7 for overall acceptability (Basic 7.9)**. The study shows that value addition of moringa leaves powder at 5% can deliver a **healthy, nutri dense food product** without compromising on color, taste, flavor and overall acceptability. The ingredients utilized in the preparation of value-added noodles can also be used in developing a wide range of diversified food products. The developed value added, ready to cook noodles is economically affordable and can be easily prepared domestically without using any synthetic preservatives, artificial flavors and artificial taste enhancers.

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