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"DEVELOPMENT AND QUALITY ANALYSIS OF FORMULATED NOODLES USING BARLEY FLOUR AND CASSAVA FLOUR (UNDERUTILIZED CROPS)"

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A B S T R A C T:

Instant noodles is one of the breakfast and staple food items of East Asian countries, whose consumption is gradually increasing day by day worldwide. Noodles are a poor source of protein and fiber due to the use of refined flour in their production. Therefore, now it is obligatory to fortify noodles with fiber-rich ingredients, which will potentially enhance not only nutritional value but also functional characteristics. The present study focuses on the fortification of fiber-rich ingredients in foods and its effects. The fortification could be optimized with the use of barley and fiber-rich ingredients as a source of fiber. To uplift the fiber content, ingredients like cassava and barley are being used. Although fortification of barley in noodles would add essential nutrient values by β-glucan and B vitamins, moreover, it balances essential protein of foods, especially lysine. *Potassium, iron, and folate exist* as principal dietary minerals of cereals. Fortification of foods with cassava possibly replaces functional characteristics of noodles like water absorption capacity, water holding capacity, texture, gelling, thickening, emulsifying, and stabilizing properties of noodles. Physiochemical analysis revealed moisture, ash of the noodles. Sensory evaluation indicated overall positive acceptance among panelists, with distinct proportions profiles observed in each variation. Furthermore, nutritional analysis showcased improvements in key parameters, including carbohydrate, protein, fat and energy content highlighting the potential of the noodles as a functional food product. In conclusion the nutritional benefits of barley and cassava flour enriched noodles can serve as a functional food option, helping to improve dietary intake, particularly among populations at risk of fibre and micronutrient deficiencies. Future research can further explore the full potential of these ingredients in food product development and their impact on long-term health outcomes..

Keywords: Instant noodles, fortification, fiber, nutrition, functional, Physiochemical analysis, Nutrient analysis.

Introduction:

It is evident that functional foods embody a fundamentally different kind of healthfulness from that of nutrition recommendations that emphasise the whole diet rather than single foods, let alone single brands. The appearance of functional foods has been characterised as a scientifically grounded, high-technology, marketing-led and unstoppable revolution in food and nutrition **(Heasman & Mellentin, 2001).** More critical perspectives have pointed out that in the best case functional foods may be a resource for promoting health, but in the worst case, they are a 'quick-fix-nutrition' that deconstruct diet into individual foods and nutrients **(Lawrence & Germov, 1999; Nestle, 2002).**

Contemporary food production and consumption are loaded with uncertainties and competing trends. Consumers are more conscious about risks relating to food than ever, especially about novel kinds of risks induced by modern technologies, such as biotechnology and genetically modified foods (Bauer & Gaskell, 2002). Consumers are not only suspicious of the safety of novel foods, but they are critical of the whole process through which food production becomes more and more anonymous and distanced from the everyday life **(Poppe & Kjaernes, 2003).** The potential erosion of public trust in food, the food system and expert knowledge regarding food safety and healthiness of food has been widely discussed in recent years **(e.g., Sassatelli & Scott, 2001).** Food choice has become an ongoing negotiation process in which consumers are faced with diverse intentions and expectations.

Extruded foods are composed mainly of cereals, starches, and/or vegetable proteins. The major role of these ingredients is to give structure, texture, mouth feel, bulk, and many other characteristics desired for specific finished products **(Launay and Lisch; 1983; Jamora et al.,2002; Tahnoven *et al*., 1998).** The success or failure of a new extruded snack food product is directly related to the sensory attributes, where texture plays a major role. Consumer acceptance of extruded foods is mainly due to the convenience, value, attractive appearance and texture found to be particular for these foods, especially when it concerns snack products (**Anton and Luciano, 2007; Harper., 1981**). Apart from their sweet or salty taste, for the majority of consumers attributes like crunchiness or crispiness are most important (**Corradini and Peleg.,2006).**

Instant noodles are fortified either by the fortification of flour used to make noodles by addition of gluten, other flours such as soya, buckwheat (Van Hung et al., 2007), oats, barley and legumes flour or by fortifying the seasoning consumed along with the noodles. Micronutrients including vitamin A, B1, B2, niacin, folic acid, iron, and iodine can be added after considering their stability during processing and recommended daily values. Calcium carbonate and gluten are also added to improve the nutritional properties of instant noodles. Fortification of instant noodles with vitamin A, B1, B2, niacin, B6, folic acid, iron, and casein (milk protein) was initiated in 1994 in Indonesia. However, fortification is not mandated by government regulations. Currently, about 80% of instant noodles produced in countries like Phillipines are fortified voluntarily. In 1997, the FOSHU (Food specified for health use) approved a health claim for psyllium in instant noodles. Fortifying the seasoning rather than the flour has an advantage that the fortificants are not exposed to heat and moisture during noodle processing. In addition, the fortificants are better protected being packed in a sachet. Table 4 enlists some fortificants used to improve the nutritional properties of noodles **(Gulia N *et al*.,2014).**

The question of when noodles were first introduced to either Indian or Chinese society and the debate about which nation managed to come up with the idea first is one that people fail to agree upon. Constant arguments for either side have been somewhat mitigated by the possibility that both nations managed to come up with the idea on their own. However, one important fact that both sides agree on when discussing the potential introduction and migration of noodles between food cultures is that their consumption well predates Marco Polo's original travels along the Silk Road. Much like the case for China and Italy, various sources note that noodles have existed in Indian food culture for an extremely long time. Specifically, food historians point the fact that "finger millet or ragi is one of the ancient millets in India **(2300 BC)**" (**Shobana *et al*., 2013**).

The fact that India has had noodles and its associated products in their food culture for well over 4000 years is extremely telling. As a result of this extremely early historical introduction of the noodle, one can expect it to have successfully penetrated Indian society and its storied food traditions. This idea is reinforced by the way that the noodle is discussed in common publications of this day, with yoga guru Baba Ramdev discussing how "noodles are very much Indian. They are integral to the cuisine of many of our North-eastern states." **(Kumar, 2022)** However, even though the noodle had over 4000 years to complete this process of integration into Indian food culture, the food still needed to prove its worth to Indian society as worthy of acceptance. Highlighting the various characteristics and aspects of noodle tradition made it fit into the Indian community is the second important temporal point of discussion and exploration that will allow for a more robust understanding of its place in Indian society.

Barley was recognised early on as a hearty tasting, high-energy food. For example, the Roman gladiators were known as "hordearii" or "barley men" for eating barley to give them strength and stamina (**Percival., 1921).** Given what we know today, the major advantage of incorporating barley into various food products and their consumption stems from barley's potential health benefits. The effectiveness of barley β-glucans in barley food products in lowering blood cholesterol **(Behall *et al*., 2004, Fadel *et al*., 1987, Newman *et al*., 1989),** and glycemic index (Braaten et al., 1991, Cavallero et al., 2002, Wood et al., 1990) has been reported in numerous publications and is widely accepted (Pins and Kaur, 2006). Barley is a rich source of tocols, including tocopherols and tocotrienols, which are known to reduce serum LDL cholesterol through their antioxidant action **(Qureshi *et al*., 1986, Qureshi *et al*., 1991).** The recent approval of soluble barley β-glucan health claims by the Food and Drug Administration of the USA for lowering blood cholesterol level could further boost food product development from barley and consumer interest in eating these food products.

Barley is a nutrient-rich grain containing minerals like calcium, zinc, iron, potassium, phosphorus, and magnesium. Magnesium supports bone health and regulates muscle and nerve function, while phosphorus is vital for tissue and cell maintenance. Zinc helps with wound healing and immunity, and iron is essential for oxygen transport in the body. Potassium aids in nerve function, muscle contraction, and blood pressure regulation. Though barley has low calcium levels, it still contributes to bone and dental health. This affordable and long-lasting grain is a nutritious addition to your diet **(Raj, R *et al*.,2023).**

Cassava was introduced in India during the later part of the 18th Century. Due to summer monsoonal circulation, the weather and climate are subjugated by largest seasonal mode of precipitation around the world. This seasonal mode, the precipitation variability has predominant inter-annual and intra-seasonal, giving rise to extreme seasonal anomalies resulting large scale drought, floods, heavy rain, hailstorms, heat stress and high wind extremes. This crop can be cultivated up to an elevation of 1000 m. Adaptability to poor soils, an ability to establish in high as well as low rainfall areas, and relative resistance to pests and diseases are a few factors that helped to anchor Cassava in Tamil Nadu. The diversity in cassava genotypes accounts for differences in end-product properties, and would require characterization of cassava varieties for suitability of culinary and processing. Amylose content is the main genetic trait for discriminating the cassava varieties for gelatinization and pasting processes including resistant starches(**Kalarani, M. K *et al*.,).**

In modern medicine no satisfactory effective therapy is still available to cure diabetes mellitus, which is a syndrome resulting from a variable interaction of hereditary and environmental factors and characterized by abnormal insulin secretion (Type-1) or insulin receptor or post-receptor (Resistance, Type- 2) events affecting metabolism involving carbohydrates, proteins and fats in addition to damaging â-cells of pancreas, liver and kidney in some cases. Several attempts have been made to tackle hyperglycemia and comorbidities (Cardiovascular, renal, hepatic, ophthalmic, neurological and osteopathic endothelial-and sexual-dysfunction, etc.) that come with increased blood glucose level. To this effect drugs like sulfonylurea that stimulate insulin secretion by the islets and a-glucosidase inhibitors that augment glucose utilization and suppress glucose production have been developed. Despite the limited efficacy of these therapies, it is also not devoid of side effects, therefore necessitating the search for new classes of drugs to combat this disorder. To this effect, many substances from plant source have been found to possess anti-diabetic activity with minimal side effects and the search is on-going.

There is a trend towards using natural products to control hyperglycemia and associated pathologies. Cassava has been rediscovered as a medicinal agent Cassava has been reported to have a broad spectrum of biological activities; the anti-oxidant, oxygen radical scavenging activity of cassava (And its extracts) is mainly due to the presence of phenolics and flavonoids The beneficial effects of cassava in diabetes have been confirmed by-a number of studies in experimental animals **(Dorota.L.,et al.,2014).**

Materials and Methods:

2.1 Selection of Ingredients

The primary ingredients selected for noodle formulation were *barley flour* and *cassava flour* due to their nutritional benefits and functional properties. Barley is rich in dietary fibre, particularly beta-glucan, which aids in digestion and improves heart health. Tapioca flour, derived from cassava roots, provides elasticity to the noodles, enhancing their texture.

2.2 Preparation of Ingredients

The selected ingredients were processed to ensure uniform particle size and quality before use in noodle formulation.

- *Preparation of Barley Flour:*
  - Barley grains were *collected* and thoroughly cleaned to remove impurities.
  - The cleaned barley grains were *roasted* at a moderate temperature to enhance their flavour and shelf life.
  - After cooling, the roasted barley was *ground into a fine flour* using a milling machine.
  - The flour was then *sieved* to obtain a uniform particle size for noodle preparation.
- *Preparation of Cassava Flour:*
  - Fresh cassava roots were *collected and washed thoroughly* with clean water to remove soil and impurities.
  - The *outer skin of cassava was peeled off* to remove any toxins and fibrous layers.
  - The peeled cassava was *grated into fine shreds* to facilitate drying.
  - The grated cassava was *sun-dried for two days* to reduce moisture content and improve storage stability.
  - Once completely dried, the cassava was *ground into fine flour* and *sieved* to achieve a uniform consistency suitable for noodle preparation.
  - The prepared *barley flour* and *cassava flour* were then stored in airtight containers until further use in noodle formulation.

2.3 Formulation of Barley and Cassava Flour-Based Noodles

The noodles were formulated using different ratios of barley flour and tapioca flour to achieve optimal *texture, elasticity, and nutritional value*. A control sample, consisting of wheat-based noodles, was prepared for comparative analysis.

The different formulations were designed to evaluate the impact of flour composition on *dough consistency, cooking properties, and sensory attributes*.

In this study, the noodles were prepared with barley flour, cassava flour and other ingredients used were standardized and their quantities for preparing the noodles were discussed in the Table below

Ingredients Used For Barley Flour and Cassava Flour Incorporated In Noodles

Ingredients	Control	Experimental		
		V1	V2	V3
Wheat flour	100g	50g	50g	50g
Barley flour	-	-	50g	25g
Cassava flour	-	50g	-	25g

2.4 Organoleptic evaluation

Sensory Quality can be defined as Colour and Apperance, Taste, Texture and Overall Acceptability. It constitutes an indispensable tool to obtain information on the aspects of the food quality to which no other analysis constitutes can be applied **(Molnar *et al*..,1995).**

The formulated recipes like noodles were given to 15 semi-trained panel members for evaluation of organoleptic characteristics of the product. Characteristics such as colour& appearance, flavour, texture and taste were evaluated. A five point hedonic rating scale was used for sensory evaluation.

2.5 Nutritional Analysis

Nutrients such as Moisture and ash, Fat, Fibre, Protein and Iron were analysed using standard procedure by reference for the selected products. The standard procedures used for the analysis of nutrients.

2.6 Storage life

The selected value added products were stored in zip lock cover for a10 day's interval and evaluated for their changes in sensory attributes were done for 15 days.

2.7 Microbial analysis

The growth of micro-organism such as Bacteria, Mould or Fungi in the Value Added Product were analysed at initial and final stages (15 days).The Standard Plate Count Method (AOAC,1990) was used for microbial analysis to evaluate the quality of formulated Value Added Product.

2.7 Analysis of Antioxidant activity

The antioxidant activities of Barley flour and cassava flour incorporated noodles were analysed (Spectrophotometric method).

2.8 Statistical Analysis.

The experimental data, including sensory evaluation and nutrient analysis, were compiled and statistically analysed. Mean, standard deviation, and ANOVA tests were used for the formulated products. Sensory evaluation data were systematically arranged for further analysis. Nutritional analysis results were also organized accordingly. ANOVA was performed at a 0-0.05 significance level, with Duncan's test for mean separation when significant differences were found. All statistical analyses were conducted using SPSS software.

Results and Discussion:

3.1 Organoleptic Evaluation

S.NO	CRITERIA	CONTROL	VARIATION I	VARIATION II	VARIATION III
1.	Colour and Apperance	7.75±1.06	7.33±0.615	6.62±0.74	7±0.79
2.	Flavour	8.25±0.73	6.62±0.74	6.37±0.63	7.75±0.99
3.	Texture	8.25±0.63	6.33±1.12	5.37±0.99	8.12±1.11
4.	Taste	8.25±0.63	6.5±1.24	6.5±0.83	8.62±0.73
5.	Overall Acceptability	8.25±0.73	6.5±0.99	5.75±0.59	8.12±0.89

Values are mean±S.D (n=15)

From the above table, it was observed that Variation III received the highest score in the texture category, followed closely by the Control sample. The Control sample had the highest scores in flavour and taste, followed by Variation III. When comparing colour and appearance, the Control sample scored the highest, followed by Variation I.

In terms of overall acceptability, the Control sample had the highest score, followed closely by Variation III, making it the most preferred among the formulated variations. Variation II had the lowest scores in all aspects, indicating the least acceptability

Attributes	Variance	Sum of Squares	df	Mean Square	F	Sig.
Colour and Appearance	Between Groups	3.000	3	1.000	1.500	0.225
	Within Groups	37.333	56	0.667		
	Total	40.333	59			
Flavour	Between Groups	10.267	3	3.422	5.528	0.002
	Within Groups	34.667	56	0.619		
	Total	44.933	59			
Texture	Between Groups	24.983	3	8.328	8.594**	0.000
	Within Groups	54.267	56	0.969		
	Total	79.250	59			
Taste	Between Groups	16.317	3	5.439	6.819	0.001
	Within Groups	44.667	56	0.798		
	Total	60.983	59			
Overall Acceptability	Between Groups	19.383	3	6.461	9.623**	0.000
	Within Groups	37.600	56	.671		
	Total	56.983	59			

3.2 ANOVA

Highly significance difference was observed on the attribute, overall acceptability

F (9.623)** of the noodles prepared out of the barley and cassava flour at 1%level among the noodles variables significance difference at 1%level was observed by using **ANOVA (one –way)**And also another significant difference was found in texture **F(8.594**)** of the noodles prepared out by barley and Cassava flour at 1%level among the noodles variables significance difference at 1%level was observed.

3.3 Physico-Chemical Analysis

Physico-Chemical analysis of formulated noodles

S.NO	PARAMETERS	CONTROL	VARIATION III
1.	Moisture(g)	12.2	6.23
2.	Ash(g)	1.47	4.91

From the above table, the moisture content of the control and test sample ranged from 12.2 to 6.23 g per 100 g. The ash content of the control and experimental sample was found to be 1.47 and 4.91 g per 100 g.

3.4 Macro-Nutrients Analysis of Formulated Noodles

S.NO	PARAMETER	CONTROL	VARIATION III
1.	Energy(kcal)	341.00	367.04
2.	Carbohydrate (g)	69.40	80.92
3.	Protein(g)	12.10	5.62
4.	Fat(g)	1.70	1.32

5.	Fibre (g)	1.90	9.76

From the above table, the Energy and Carbohydrate content of Control and Variation III noodle samples are in the range of **341.00 to 367.04 kcal per 100g** and **69.40 to 80.92 g per 100g**, respectively. The Protein and Fat content of Control and Variation III samples are in the range of **12.10 and 5.62 g per 100g** and **1.70 and 1.32 g per 100g**, respectively. The Fibre content of the Control and Variation III noodle samples ranges from **1.90 to 9.76 g per 100g**.The results indicated that the incorporation of barley and cassava flour in Variation III led to an increase in carbohydrate and fibre content, while protein and fat content decreased compared to the Control sample. The significant increase in fibre content suggests that the noodles formulated with barley and tapioca flour could offer potential health benefits, such as improved digestion and better glycemic control. The experimental noodle sample (Variation III) containing barley and cassava flour had the maximum fibre content, demonstrating the beneficial impact of this formulation when compared to the Control sample.

3.5 Micro-Nutrients Analysis of the Formulated Noodles.

S.NO	PARAMETERS	CONTROL	VARIATION III
1	*Phosphorus*	121	255
2	Iron	2.17	2.57

From the above table, the phosphorous content of the control and test sample ranged from 121g and 255 per 100 g. The Iron content of the control and test sample was found to be 2.7 and 2.57g per 100 g.

3.6 Microbial Analysis of Formulated Noodles

Sample	Microbial Load	Storage Period	
		Initial(0 day)	Final(15 days)
Control	Total Microbial Count	<10(ND)	<10(ND)
Variation III	Total Microbial Count	<10(ND)	<10(ND)

The above table shows that there is no presence of bacteria, fungi and yeast in the sample noodles and safe for consumption.

3.7 Antioxidant activity

PARAMETER	CONTROL	VARIATION III
Flavonoids	50	56.4

The flavonoid content in Variation III (56.4 mg) was higher than in the Control (50 mg), indicating that the incorporation of barley and cassava flour enhanced the antioxidant properties of the noodles. This increase suggests potential health benefits, such as improved immune function and reduced oxidative stress.

Conclusion:

In conclusion , the present study focused on the formulation and evaluation of noodles made with barley and cassava flour. Barley and cassava flour are underutilized but highly nutritious food sources with immense potential for improving dietary quality. Barley is rich in dietary fibre, particularly beta-glucan, which has been linked to various health benefits, including improved gut health and cholesterol regulation. Cassava flour, derived from the cassava root, is gluten-free and provides a good source of carbohydrates and minerals. In this study, barley flour and cassava flour were incorporated with wheat flour at different proportions to develop fibre-rich noodles, and their quality characteristics, nutritional composition, and physico-chemical parameters were analysed.The results indicated that the incorporation of barley and cassava flour up to a certain level enhances the nutritional value of noodles, significantly increasing dietary fibre, phosphorus, and antioxidant content. Sensory evaluation revealed that Variation III was the most preferred formulation, exhibiting good texture and overall acceptability. The developed noodles also demonstrated better shelf stability, with microbial growth remaining within safe limits over a 30-day storage period. Additionally, the cost analysis showed that these value- added noodles are economically viable, making them a practical alternative to conventional noodle products. Given the nutritional benefits of barley and cassava flour, these enriched noodles can serve as a functional food option, helping to improve dietary intake, particularly among populations at risk of fibre and micronutrient deficiencies. Future research can further explore the full potential of these ingredients in food product development and their impact on long-term health outcomes.

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REFERENCES:

1. 1.Niva, M. (2007). 'All foods affect health': understandings of functional foods and healthy eating among health-oriented Finns. *Appetite*, *48*(3), 384-393.
2. Gulia, N., Dhaka, V., & Khatkar, B. S. (2014). Instant noodles: processing, quality, and nutritional aspects. *Critical reviews in food science and nutrition*, *54*(10), 1386-1399.
3. 3.Saeleaw, M., Dürrschmid, K., & Schleining, G. (2012). The effect of extrusion conditions on mechanical-sound and sensory evaluation of rye expanded snack. *Journal of Food Engineering*, *110*(4), 532-540.
4. Anton, A. A., & Luciano, F. B. (2007). Instrumental texture evaluation of extruded snack foods: a review evaluación instrumental de textura en alimentos extruidos: una revisión. *CYTA-Journal of Food*, *5*(4), 245-251.
5. Obradović, V., Babić, J., Šubarić, D., Ačkar, Đ., & Jozinović, A. (2014). Improvement of nutritional and functional properties of extruded food products. *Journal of Food & Nutrition Research*, *53*(3).
6. Shetty, V. (2022). The Historical Role of the Noodle in Indian Society by Vaishnav Shetty. *Noodles on the Silk Road. Accessed January*, 442-49.
7. Baik, B. K., & Ullrich, S. E. (2008). Barley for food: Characteristics, improvement, and renewed interest. *Journal of cereal science*, *48*(2), 233-242.
8. Raj, R., Shams, R., Pandey, V. K., Dash, K. K., Singh, P., & Bashir, O. (2023). Barley phytochemicals and health promoting benefits: A comprehensive review. *Journal of Agriculture and Food Research*, *14*, 100677.
9. Boukhers, I., Boudard, F., Morel, S., Servent, A., Portet, K., Guzman, C., ... & Poucheret, P. (2022). Nutrition, healthcare benefits and phytochemical properties of cassava (Manihot esculenta) leaves sourced from three countries (Reunion, Guinea, and Costa Rica). *Foods*, *11*(14), 2027.