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Development of tapioca (*Manihot esculenta* Crantz) flour-based extruded vermicelli

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Abstract

Extruded products are widely regarded as a conventional food around the world, due to its convenience, versatility, and ease of preparation. The study evaluated the acceptability of vermicelli made with supplementation of tapioca flour at different levels (80, 70, 60 and 50%). The organoleptic evaluation revealed a significant difference among the formulations for attributes, and in range between like moderately to like very much. The proximate composition of vermicelli showed high levels with more percent of tapioca substitution when compared with control. Vermicelli with 80 percent tapioca flour was highly accepted. The storage studies of the vermicelli was found to be great both organoleptic ally and nutritionally with slight changes.

Keywords: Extruded products, tapioca, vermicelli, storage

Introduction

Extrusion cooking is one of the most significant and rapidly expanding food processing techniques used to create manufactured meals today. It has been widely utilised to generate Ready to Cook (RTC) foods that may be served immediately and Ready to Eat (RTE) foods that rely on expansion at the die to achieve the proper texture and size. Numerous benefits of this technology include its adaptability, affordability, and superior product quality. Macaroni, noodles, spaghetti, vermicelli, and other pasta products are extruded items. Due to their ease and ready-to-cook nature, vermicelli/noodles are a favourite among youngsters and various age groups.

The need to replace wheat flour with other sources has grown in recent years. These days, wheat vermicelli have been strengthened with a variety of substances to improve the kinds of vermicelli. So, as a part of replacement tuber flour was tried. Roots and tubers are gluten free and are a rich source of carbohydrate and starch, helps to determine the textural properties of products like vermicelli and noodles. Composite flour technology refers to the technique of blending different flours from tubers with cereals or pulses in accurate proportions, with or without the inclusion of wheat flour, in order to make economic use of locally grown products and produce high-quality food items (Sheikh *et al.*, 2021)^[8].

Tapioca flour was substituted to develop vermicelli. Tapioca (*Manihot esculenta* Crantz) belong to the family Euphorbiaceae, is an energy-dense food, starchy and a good source of carbohydrate and calories which is available seasonally. Globally tapioca stands first among the tropical root and tuber crops and is considered as king of tropical tuber crops as it occupies a significant position in the global agricultural economy and trade amongst the tuber crops. (Brahma *et al.*, 2022)^[2]. After rice, wheat and maize, tapioca is the staple crop in many developing countries.

Tapioca provides high energy at lower cost which encourages its utilization among low-income groups. The most popular processed food of tapioca in India are chips and sago. Processing of tapioca flour into value added product like vermicelli have the potential to increase income and improve the livelihood of tapioca growers. Apart from value addition, through novel food products development there is also scope for variety, convenience and cost efficiency. Hence, the study was conducted to develop tapioca flour incorporated vermicelli.

Materials and Methods

The present study was conducted in the Department of Food and Nutrition, College of Community Science, of Guntur district in Andhra Pradesh state of India during the year 2023.

Procurement of raw materials

Tapioca was procured from the local markets of Srikakulam district, Andhra Pradesh, India. And other raw ingredients were purchased from the local markets in Guntur district.

Processing of tapioca into flour

A modified version of the Tharise *et al.* (2014) [9] method was used to prepare tapioca flour. The tapioca tubers were thoroughly cleaned, peeled, and cut into 2mm slices before blanching in hot water for 1 minute. The blanched slices were spread in a cloth to remove excess moisture before being placed in a tray and oven dried at 60 °C for 8-10 hours. The dry pieces were ground to make flour. The flour was sifted via a mesh sieve and kept in high density polyethylene (HDPE) pouches before use.

Preparation of Vermicelli

Tapioca, wheat and refined wheat flour were sieved together in the ratios as shown in the table 1. Salt was added to the sieved flour and combined well. Water was added to the flour and combined well into a powdery course texture. Then the powdery flour mixture was placed in an extruder and extruded. Extruded vermicelli was dried in the oven at 60°C. The dried vermicelli can be used in cooking various products like Upma, Kheer. In the present study developed vermicelli was made into Kheer for organoleptic evaluation.

Table 1: Flour blends

Treatments	Tapioca flour (%)	Wheat flour (%)	Refined wheat flour (%)
T1 (control)	0	100	0
T2	80	10	10
T3	70	15	15
T4	60	20	20
T5	50	25	25

Determination of proximate composition of biscuits

The proximate composition (moisture, protein, ash, fat, fiber, carbohydrate and energy) of biscuits were determined by the method described by AOAC (2000) [1]. The carbohydrate and energy values are determined by difference respectively.

Organoleptic evaluation

The organoleptic analysis was analysed in the Food and Nutrition laboratory by 25 members consists of Assistant professors and research scholars from the College of

Community Science. The colour, flavour, taste, texture, appearance, and overall acceptability were rated by the panel members using a nine-point hedonic scale ranging from 1-dislike extremely to 9-like extremely. The organoleptic examination was carried out at room temperature, and the panel members were given vermicelli kheer samples labelled with code numbers.

Statistical analysis

Mean and standard deviation was used. To identify any significant differences between the attributes of formulations, the mean values of the organoleptic evaluation data were evaluated using the Krushkal Walli H-test which is a one-way analysis and non-parametric.

Storage studies

The highly accepted formulation was subjected to storage studies. The vermicelli was stored in high density polyethylene (HDPE) pouches at ambient temperature for a period of 30 days. At an interval period of 15 days, 10 percent of storage sample was subjected to organoleptic evaluation using a nine-point hedonic scale and nutritive composition was analysed.

Results and Discussion

Organoleptic evaluation of vermicelli Kheer

From figure 1, it was observed that there was a significant difference (4 degrees of freedom) in all sensory attributes of all treatments of vermicelli Kheer. The mean scores of colour ranged from 7.1 to 8.2. Among all T2 scored the highest while T3 scored the lowest. Results of appearance range from 6.7(liked slightly) to 8.2(liked very much). Vermicelli made with variation of 80% tapioca flour, 10% wheat flour and 10% refined wheat flour (T2) scored highest in flavour, texture and taste attribute with a mean score of 7.9, 8.4 and 7.9 while T4 score the least with mean value of 7.1, 6.3, 7.1 respectively. For the attribute of overall acceptability, T2 (80:10:10) significantly differs with all variations at 4 degrees of freedom with the mean score of 8.1. The minimum score was 7.1 for the variations T3 and T5. Similar results were reported by Dhas *et al.* (2021) [3] documented that pasta made with 70% foxtail millet and 30% tapioca flour had the highest score for all sensory parameter and noodles incorporated with 20% potato flour with 10% rice flour obtained highest overall acceptability in the study of Sheikh *et al.* (2021) [8].

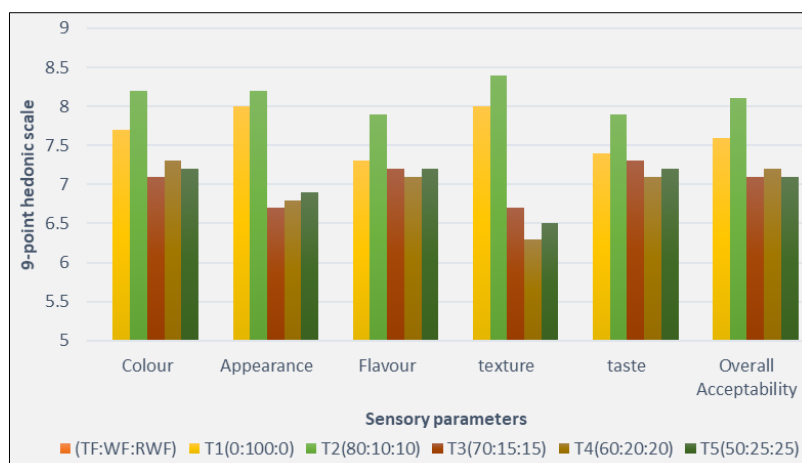


Fig 1: Organoleptic score of Vermicelli Kheer

Proximate composition of Vermicelli Kheer

Table 2 depicts the mean values of proximate composition per 100g of tapioca flour incorporated vermicelli Kheer per 100 g.

Table 2: Proximate composition of vermicelli Kheer

Treatments (TF:WF:RWF)	Proximate Composition (g %)						
	Moisture	Protein	Fat	Ash	Crude fiber	CHO	Energy (Kcal)
T1 (0:100:0)	34.62	6.10	3.04	1.32	0.70	54.21	269
T2 (80:10:10)	34.24	3.10	2.77	0.92	0.50	58.48	271
T3 (70:15:15)	34.31	3.45	2.79	0.92	0.49	58.05	271
T4 (60:20:20)	34.39	3.80	2.80	0.92	0.47	57.62	271
T5 (50:25:25)	34.46	4.15	2.82	0.92	0.46	57.19	271
Mean	34.40	4.12	2.84	1.00	0.52	57.11	270
SD	0.147	1.176	0.109	0.179	0.101	1.688	1.085
Lowest range	34.24	3.10	2.77	0.92	0.46	54.21	269
Highest range	34.62	6.10	3.04	1.32	0.70	58.48	271

TF- Tapioca Flour WF- Wheat Flour RWF- Refined Wheat Flour

All the values of parameters of vermicelli kheer increased with a decrease in proportions of tapioca flour with wheat and refined wheat flour, at the same time carbohydrate value decreased with decrease in proportion of tapioca flour. The moisture content in vermicelli kheer was found to be 34.40 percent on average. Control vermicelli kheer (T1) had the highest value (34.62 percent), while T2 had the least value (34.24 percent). The average protein content of vermicelli kheer variations was found to be 4.12 percent. The lowest value 3.10percent was observed for T2 combination and the highest value was recorded for T5. The fat content of tapioca flour vermicelli was found to be 2.84 percent on average. The highest fat content was observed in control vermicelli (T1) while lowest was observed for T2 variation. The ash content was found to be 1.0 percent on average and T1 recorded the highest ash content with 1.32 percent. Similarly, T1 obtained highest crude fiber content with 0.70 percent while T5 scored least with 0.46 percent. The average crude fiber content was found to be 0.52 percent. The carbohydrate content of tapioca vermicelli Kheer results showed an average value of 57.11percent with a maximum value of 58.48 percent for 80% tapioca-incorporated vermicelli (T2). The lowest carbohydrate value was observed for vermicelli with 100% wheat with the value of 54.21 percent while the highest was observed in vermicelli with 80 percent tapioca flour. This may be as a

result of the high contents of carbohydrate in cassava flour. (Sanni *et al.*, 2007) ^[7]. The average energy value for vermicelli was found to be 270 Kcal/100 g. The lowest value was observed in 0% tapioca flour vermicelli (271 Kcal/100 g). According to the previous study of Sanni *et al.*, (2007) ^[7], the percent of incorporation of cassava flour in noodles sample increased, there was an increase in carbohydrate and fiber content and decrease in fat and protein content of noodles sample. Similar results were observed in the studies of Sheikh *et al.* (2021) ^[8], Mithila *et al.* (2021) ^[6] and Kiruthika *et al.* (2023) ^[5] in noodles developed from potato, sweet potato flour and tapioca vermicelli infused with dates flour.

Storage studies of vermicelli

The shelf-life qualities of highly accepted vermicelli formulation which was 80% tapioca flour incorporated vermicelli were stored in an High-Density Polyethylene (HDPE) pouch for a period of 30 days in a clean, dry, and well-ventilated room. For every 15th day, 10% of the stored sample is subjected to organoleptic evaluation and proximate composition.

Effect of storage on organoleptic evaluation of vermicelli Kheer: The impact of storage on the sensory characteristics of vermicelli was shown in figure 2.

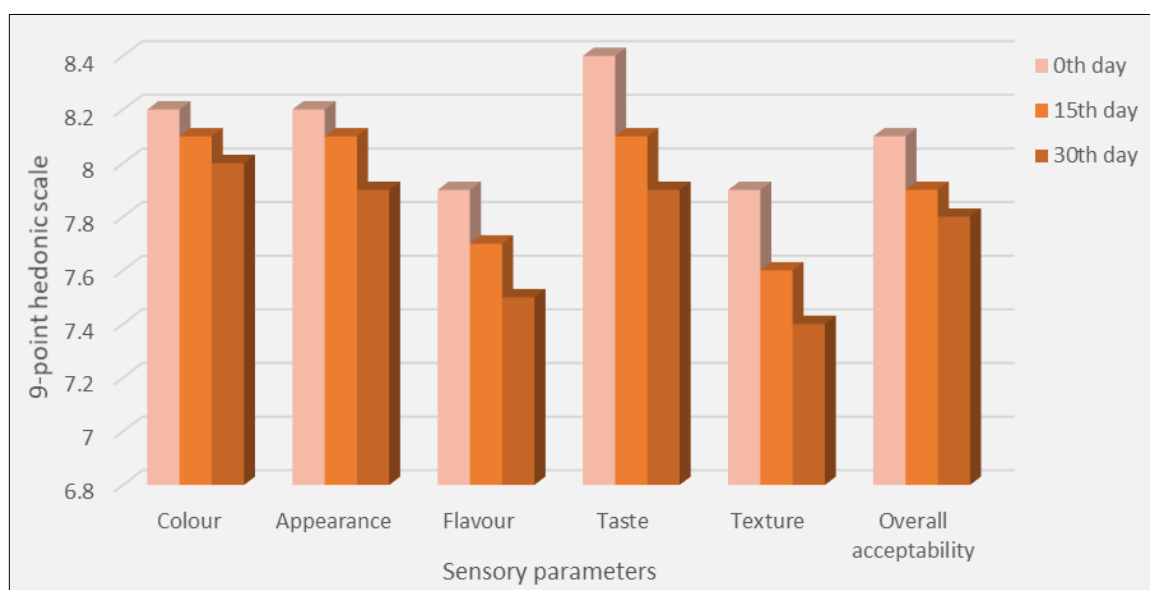


Fig 2: Effect of storage on organoleptic evaluation of vermicelli Kheer

One of the prominent quality aspect of the food is colour. The mean scores of colour aspects of vermicelli reduced from the initial day to the 30th day from 8.2 to 8.0 (like very much). The mean score of appearance on the 30th day of storage was 8.1 and 7.9 on the initial day of storage. The decreased trend continued for flavour, taste and texture aspects of vermicelli during storage. The values changed from 7.9, 8.4 and 7.9 on initial day to 7.5, 7.4 and 7.8 on final day of storage. This may be due to changes in moisture content and chemical composition of flours. The overall acceptability was observed to change from like very much (8.1) on initial day to like moderately (7.8) on 30th day. Prior studies by Elisabeth and Setijorini (2016) [4] examined the shelf life of dry noodles made sweet potato and colacasia composite flour and found that the noodles could be kept at 30 °C up to 46 weeks (324 days). The dry noodles made from composite flour (mocaf, tapioca, corn starch and soybeans) had a shelf life of 161 days at 25 °C, 194 days at 35 °C and 231 days at 45 °C, according to a study by Violalita *et al.* (2021) [10].

Effect of storage on proximate composition and free fatty acids of vermicelli

The effect of storage on proximate composition and free fatty acids of dry vermicelli were depicted in table 3.

Table 3: Effect of storage on proximate composition and free fatty acids of vermicelli

Proximate composition (g %)	0 th day	15 th day	30 th day
Moisture	11.7	11.78	11.84
Protein	3.99	3.91	3.85
Fat	0.99	0.95	0.91
Ash	1.61	1.59	1.58
Crude fiber	1.34	1.32	1.31
CHO	80.37	80.45	80.51
Energy (Kcal)	346	346	345
Free fatty acids (mg KOH/g)	0.36	0.40	0.43

From table 3 it was inferred that proximate composition and free fatty acids changed during a storage period of 30 days. The progressive increase in moisture content was observed from 11.7 percent on the initial day to 11.84 percent on the 30th day of storage. The amount of protein content decreased from 3.99 percent to 3.85 percent during storage. A decrease in fat content was observed from 0.99 to 0.91 percent during storage. The lowest ash content value was observed on 30th day of storage (1.58 percent) while the highest value 1.61 percent was observed on initial day of storage.

Regarding the crude fiber content, a continuous decrease was observed during storage period from 1.34 to 1.31 percent. The carbohydrate values was noticed to be 80.37 percent on 0th day, 80.45 percent on 15th day and 80.51 percent on 30th day of storage. The energy values ranged from 346-345 Kcal from initial day to 30th day. Free fatty acids measures the hydrolysis of lipids and from data it is observed that free fatty acids values increased from 0.36 to 0.43 mg KOH/g during storage period of 30 days. It could be said that the proximate and free fatty acids of tapioca vermicelli was in acceptable range even after 30 days period of storage.

Conclusion

From the research conducted, it could be concluded that vermicelli can be made from tapioca flour. Vermicelli made from tapioca flour was quite promising, showing higher

acceptable rating compared to control one. The study concludes that vermicelli of acceptable nutritional and organoleptic properties could be produced from tapioca flour and its combination with other gluten free flours which could be great alternative for gluten free option. It is thus recommended that small and medium-sized food processors to use extrusion technology. This will help to boost the production and use of indigenous crops, resulting in improved food and nutrition security.

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