The Pharma Innovation Journal 2021; 10(5): 1432-1435

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(5): 1432-1435

www.thepharmajournal.com
Received: 14-02-2021
Accepted: 30-04-2021

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Development of fibre enriched ready-to-cook pasta with foxtail millet and tapioca flour

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Abstract
Pasta is generally considered as a conventional food all over the world, mainly because of its convenience, multi-purpose, easy to prepare. The present research work was carried out to develop pasta from foxtail millet and tapioca by incorporation of 50, 55, 60, 70 and 80% level of foxtail millet flour and 50, 45, 40, 30 and 20% level of tapioca flour for the different composition levels. The developed pasta was assessed for its physico-chemical, cooking quality, functional properties and organoleptic acceptability. The proximate analysis indicated the highest levels of proteins, minerals, dietary fibre, fibre, and a considerable amount of fat when compared to standard pasta. Cooking time of four variations of pasta was found significantly lower than control pasta. In control (50:50) the bulk density is higher comparing other treatments due to the incorporation of tapioca into the pasta. Pasta made with 70% foxtail millet and 30% tapioca incorporation was found to be more acceptable than other percentages of incorporation. The sensory evaluation revealed that there were significant differences among the variations for the organoleptic qualities.

Keywords: Foxtail millet, Ready-to-cook, pasta, tapioca, extrusion

1. Introduction

Consumers are increasingly demanding convenient, ready to cook and ready to eat foods containing only healthy ingredients like millets. Therefore development of innovative, nutritious and convenient foods is the need of the hour, to replace unhealthy processed foods. A Millet and Tapioca based RTC extruded product will be gluten free healthy alternative to the currently available wheat based RTC extruded products like pasta. Furthermore, there are fewer food products made from Tapioca which is an amply available underutilized crop. Hence, the present study is focused on developing Millet and Tapioca based RTC extruded product using locally available healthy and less utilized food ingredients.

The foxtail millet is also known as Italian millet which is used as astringent, digestive, emollient and stomachic. This millet contains 12.3% crude protein, 3.3% minerals and very high fibre content 14.3% (Pawar and Machewad, 2006) [9]. Among all millets, foxtail millet had the highest content of dietary fibre 11.24 g/100 g.

Tapioca is a rich source of carbohydrates and calcium and it yields greater quantum of calories per hectare than the cereals. Tapioca starch will serve as the major puffing constituent of the product and imparts the desired textural quality. Tapioca is a starch extracted from the cassava root (Srinivas and Anantharaman, 2005) [11]. Tapioca provides high energy at lower cost which encourages its utilization among low-income groups. It has high dietary fibre of 0.02-0.49% (Patel, 2012) [8].

Extrusion cooking is one of the fastest growing and most important food processing operations currently being used to produce fabricated foods. It has been widely used to produce Ready to Eat (RTE) foods that depend on the expansion at the die to produce the desired texture and size and Ready to Cook (RTC) foods that can be instantly served (Gull *et al.*, 2015) [5].

Main advantage of cold extrusion process is the greater flexibility of operation that is possible by changing the degree of intermeshing of the screws, the number of flights or the angle of pitch of the screw. Cold extrusion process handles oily, sticky, or very wet materials, or other products that slip in a single screw. The limitations for single and twin screw machines are 4% and 20% fat, 10% and 40% sugar, and 30% and 65% moisture respectively. There is therefore greater flexibility in operation using different raw materials for cold extrusion process (De Noni *et al.*, 2010) [3].

Since the major problem in millet or any other non-gluten ingredient based extruded product is maintaining the structure (Jalgaonkar, 2016) [6] partially substituting tapioca a good binding agent (Breuninger *et al.*, 2009) [2] and underutilized ingredients is a promising solution to this problem. Therefore, this study is aimed at development of gluten free RTC extruded product with Foxtail Millet and Tapioca based.

2. Materials and Methods

2.1 Raw materials

The present study was carried out in the College of Food and Dairy Technology, Koduvelli, Chennai. The raw materials chosen for this study are foxtail millet flour; tapioca flour and was procured from the local market. The other ingredients like Xanthan gum, salt, rice bran oil are also purchased from the local market in Chennai.

2.2 Formulation of pasta

Five combinations of foxtail millet and tapioca based pasta was formulated by incorporating the flour mixed at various ratios of foxtail millet and Tapioca *viz* 50:50 of foxtail millet and tapioca as control, 55:45 (treatment 1), 60:40 (treatment 2), 70:30 (treatment 3) and 80:20 (treatment 4).

For the preparation of pasta, the flours (foxtail millet and tapioca) were mixed with the 72% of moistening condition (2% gum+ 70% water) with 2% of salt to the components. Besides, 8% of rice bran oil is added to it. Then kneading is done for 15 minutes in the mixing chamber of pasta extruder to distribute water uniformly throughout the flour particles. The moist flour aggregate was placed in a metal extruder attachment of the pasta extruder machine (Model: La Monferrina- Mini Pasta Making machine) fitted with an adjustable die followed by cutting. After the extrusion process, steaming process was carried out for 10 minutes. After the preparation of pasta, the drying of pasta was carried out in a food-grade tray dryer at 60 °C for about 4 hours.

2.3 Physicochemical properties of the pasta sample

Protein, fat, fibre, Moisture, Ash content, Trans fat, Dietary fibre, Total Carbohydrate, Peroxide value, Energy, Bulk density, Water activity of pasta samples were determined using AOAC method.

2.4 Cooking Quality of pasta

2.4.1 Optimum cooking time

Optimum cooking time was determined by cooking the pasta of 25 g in 100 ml of water. The product was cooked until the white line disappears and the time taken was noted. Pressing the cooked product in between two glass slides will test the end point (Gull *et al.*, 2015) [5]

2.4.2 Cooking loss percent

Cooking loss is determined by evaporating the pasta water to dryness for overnight in hot air oven at 100 °C. The initial weight and the dried weight were noted (Giuberti *et al.*, 2015) [4].

$$\text{Cooking loss\%} = \frac{\text{Dried residue in cooking water (g)}}{\text{Pasta weight before cooking (g)} \times 100}$$

2.4.3 Swelling index

One gram of the sample was dispensed into a calibrated 50 ml measuring cylinder. To the sample, 10 ml of distilled water was added and the volume was noted. The cylinder was left to stand undisturbed for about 1 hour. Volume occupied by the sample was recorded and the swelling capacity was calculated as outlined by Nwabueze and Anoruoh (2011) [7].

$$\text{Swelling index} = \frac{\text{Volume occupied by the sample after swelling}}{\text{Initial value occupied by the sample}}$$

2.5 Functional properties of the pasta sample

2.5.1 Water solubility index

The Water solubility index was the weight of dry solids in the supernatant expressed as a percentage of the original weight of sample (Sharma *et al.*, 2017) [10]

$$\text{Water solubility index (\%)} = \frac{\text{Weight of dry solids in supernatant}}{\text{Dry weight of extrudate}} \times 100$$

2.5.2 Water absorption index

It was the quantity of water absorbed by a known quantity of the food sample. In a glass beaker, 50 g of raw pasta sample was taken. 100 ml of water was added to it. After 10 minutes the water was drained. The weight of the hydrated sample was noted and recorded (Sharma *et al.*, 2017) [10].

Water absorption index = Weight of the hydrated sample – Weight of raw sample

2.6 Organoleptic acceptability of the pasta sample

The cooked pasta was evaluated for its overall acceptability for all the treatments. The panellists were asked to evaluate the sensory quality of extruded samples as per sensory score card. Panel members were directed to judge each sample on the basis of colour and appearance, texture, taste, mouth feel and overall acceptability, and indicate their degree of liking on a 9-point Hedonic Scale.

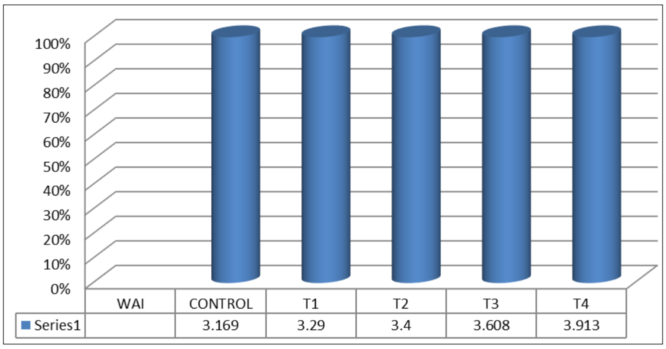
2.7 Statistical analysis

A total of six trails were conducted and the data is subjected to statistical analysis. The means were compared using Duncan's Multiple range Test of 0.05 significance using Analysis of Variance (ANOVA).

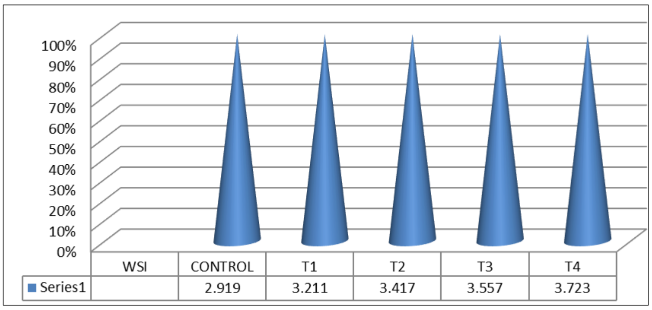
3. Results and Discussion

The mean values±SE values of the physicochemical properties of the Ready-to-cook pasta are furnished in Table 1. The protein content of the pasta is higher in T4 compared to the control sample. Fat content is higher in T4 comparing all the other treatments. Similarly, the other properties like fibre, dietary fibre, Trans fat, total ash content, moisture content, water activity, total carbohydrates, energy value was higher in T4 when compared to control and other treatments. This might be due to increase in incorporation of foxtail millet into the pasta. Inversely, bulk density is higher in control sample, when compared to other treatments. This may be due to the addition of higher content of tapioca in control sample.

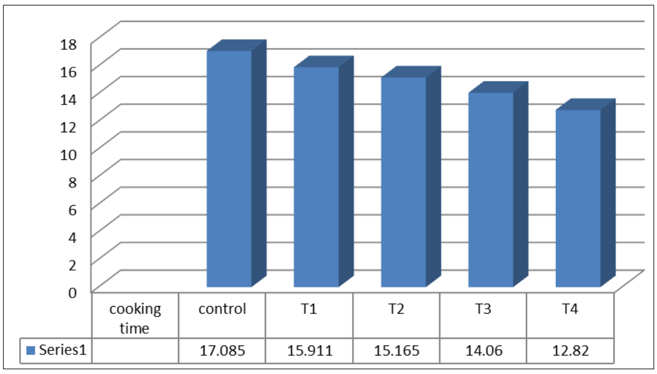
Water absorption and water solubility index was higher in T4 from the graph. This may be due to the incorporation of higher composition of foxtail millet. In the cooking quality of the pasta, optimum cooking time and cooking loss was higher for control than other treatments and this is due to addition of foxtail millet. The swelling capacity was higher in control than other treatments and this is because incorporation of higher tapioca into the pasta. Different proportion of ingredients in the preparation of RTC pasta by sensory evaluation was furnished in table 2 in which T3 ranged higher in overall acceptability comparing control, T1, T2 and T4.



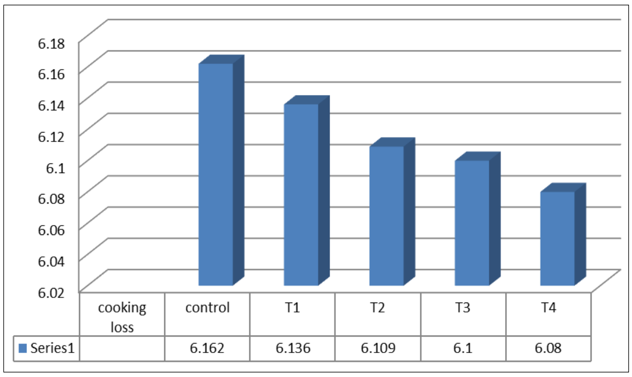
Graph 1: Mean values of Water absorption index of RTC Pasta(n=6)



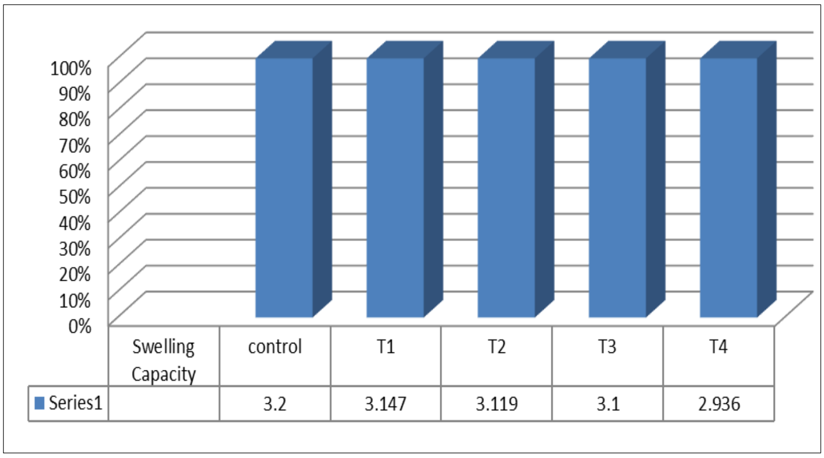
Graph 2: Mean values of Water solubility index of RTC pasta(n=6)



Graph 3: Mean values of Optimum Cooking time of RTC Pasta(n=6)



Graph 4: Mean values of cooking loss of RTC Pasta(n=6)



Graph 5: Mean values of Swelling capacity of RTC Pasta(n=6)

Table 1: Mean ±SE values of Physicochemical properties of the standardized extruded product (n=6)

Parameters	Treatments					F-Value
	Control	T1	T2	T3	T4	
Protein (g/100g)	8.227±0.094^{a}	10.149±0.098^{b}	11.249±0.078^{c}	12.181±0.073^{d}	13.227±0.152^{e}	345.751**
Fat (g/100g)	0.997±0.081^{a}	1.429±0.028^{b}	1.856±0.029^{c}	1.917±0.028^{c}	2.063±0.053^{d}	79.466**
Ash Content (g/100g)	2.498±0.005^{a}	2.506±0.032^{a}	2.508±0.002^{a}	2.535±0.012^{a}	2.610±0.002^{b}	8.495**
Trans fat (g/100g)	0.024±0.004^{a}	0.024±0.003^{a}	0.029±0.003^{a}	0.023±0.003^{a}	0.030±0.0045^{a}	0.754^{NS}
Dietary fibre (g/100g)	2.272±0.003^{a}	2.315±0.008^{b}	2.334±0.002^{c}	2.376±0.003^{d}	2.423±0.003^{e}	129.761**
Peroxide value (meq/kg)	1.94±0.094^{a}	2.071±0.107^{a}	2.046±0.153^{a}	1.889±0.064^{a}	2.061±0.173^{a}	0.424^{NS}
Bulk density (g/ml)	717.832±0.484^{e}	675.096±0.305^{d}	645.982±0.294^{c}	619.631±0.229^{b}	589.511±0.286^{a}	22334.687**
Energy (Kcal/100g)	362.440± 0.107^{a}	364.145±0.341^{b}	365.956±0.165^{c}	365.979±0.200^{c}	366.046±0.092^{c}	62.296**
Total Carbohydrates (g/100g)	80.240±0.118^{e}	77.759±0.116^{d}	76.165±0.055^{c}	75.014±0.072^{b}	73.654±0.179^{a}	476.776**
Water activity	0.422±0.012^{a}	0.433±0.010^{ab}	0.435±0.003^{ab}	0.448±0.003^{b}	0.446±0.005^{ab}	1.900^{NS}
Moisture (%)	8.717±0.020^{a}	8.813±0.033^{ab}	8.850±0.020^{bc}	8.900±0.028^{bc}	8.925±0.054^{c}	5.834**
Fibre (g/100g)	6.489±0.049^{a}	8.277±0.020^{b}	9.864±0.030^{c}	11.825±0.047^{d}	13.832±0.051^{e}	4739.429**

Means bearing various superscripts (A,B,C,D,E...) in column differs significantly ($P\leq 0.01$)
Means bearing different superscripts (A,B,C,D,E…) in row differ significantly ($P\leq 0.01$)

Table 2: Mean ± SE values of sensory attributes of RTC Pasta (n=6)

Treatments	Sensory attributes (9-point hedonic scale)				
	Colour	**Taste**	**Texture**	**Mouth feel**	**Overall acceptability**
Control	6.89 ± 0.128^{ab}	6.40 ± 0.180^{abc}	6.97 ± 0.190^{bc}	6.40 ± 0.193^{ab}	6.69 ± 0.163^{bc}
T1	6.49 ± 0.155^{bc}	6.14 ± 0.197^{ab}	6.71 ± 0.203^{ab}	6.37 ± 0.232^{ab}	6.51 ± 0.176^{ab}
T2	6.97 ± 0.112^{c}	6.86 ± 0.179^{c}	7.17 ± 0.156^{bc}	6.83 ± 0.161^{b}	7.00 ± 0.130^{bc}
T3	7.03 ± 0.166^{c}	6.77 ± 0.179^{bc}	7.26 ± 0.194^{bc}	6.97 ± 0.203^{b}	7.20 ± 0.147^{c}
T4	7.11 ± 0.128^{c}	6.69 ± 0.220^{bc}	7.34 ± 0.158^{c}	6.69 ± 0.224^{b}	7.03 ± 0.139^{bc}
F value	3.921^{**}	3.237^{**}	4.522^{**}	2.855^{**}	4.598^{**}

Means bearing various superscripts (A,B,C,D,E...) in column differs significantly ($P\leq 0.01$)
Means bearing different superscripts (a,b,c,d,e…) in row differ significantly ($P\leq 0.01$)
Control – Foxtail millet (50): Tapioca (50)
Treatment 1 – Foxtail millet (55): Tapioca (45)
Treatment 2 – Foxtail millet (60): Tapioca (40)
Treatment 3 – Foxtail millet (70): Tapioca (30)
Treatment 4 – Foxtail millet (80): Tapioca (20)

4. Conclusion

Pasta supplemented with foxtail millet and tapioca can be produced with blend ratio of 70% foxtail millet and 30% tapioca ranged with higher overall acceptability. Pasta having 80% of foxtail millet and 20% tapioca that is treatment 4 ranged high in more physico-chemical properties. Pasta has a higher demand and a suitable carrier for the people who are health conscious which nutrition factor. The addition of nutrient-rich foxtail millet in a long way it improves the health status of the vast majority of the health-conscious population**.** This type of gluten-free pasta products can go a long way in supplying the required quantities of nutritional values to various segments of our populations and will also result in profitable utilization in the food industry.

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