The Development of Food Product Dosa Through Waterchestnut (*Trapa natans*) Flour Prepared by Various Methods

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Abstract: The idea of healthy and nutritionally rich snack is fulfilled by incorporating waterchestnut flour rice and black gram. In India, nutritional deficiency is common. In Southern Indian, dosa is typical part of staple diet and popular all over the Indian subcontinent. The present study was planned to evaluate the organoleptic attributes and nutritive value of dosa prepared with incorporation of waterchestnut flour in different ratio. The food product was organoleptically evaluated by using Nine points hedonic scale for the appearance, colour, texture, taste, after taste and flavour of dosa. The result of oorganoleptic evaluation of the samples were revealed the T_4 (20% waterchestnut flour) was best as compared to control and other treatments, however all the treatments were acceptable. Incorporation of rice, black gram and waterchestnut flour in dosa batter was well acceptable along with health benefits and can be used for the development of food product dosa.

Keywords: Waterchestnut, Nutritional deficiency, Fermentation, Dosa, Organoleptic characteristic.

I. Introduction

The requirement of nutritionally rich and healthy snacks is fulfilled by incorporation of flours. Nutritional deficiency is common in India. Some efforts are ongoing to enrich cereals, in supplement with, vegetable is used in effective manner (Pragati and Paul, 2010). Rice flour is commonly known as *chawal ka atta.* It is used to prepare of different variety of delicious snacks. Dosa is a type of pancake, made up with fermented batter. The ingredients of dosa are rice, blackgram and fenugreek seeds. In Southern Indian, dosa is typical part of staple diet and popular all over the Indian subcontinent. Traditionally, dosa is served along with sambar and coconut chutney (Sathiya and Chithra, 2019). It is light on the stomach and is great for a good nutritional breakfast (Sulochana, Bakiyalakshmi, 2011). Fermentation of food product is batter to improve the nutrition and protein value of dosa (Aishwarya and Jahan 2021).

Waterchestnut (*Trapa bispinosa Roxburg*) is an annual aquatic warm season crop and it is commonly known as Singhara (Singh *et al*., 2010). It has many medicinal properties to treat many diseases such as liver, stomach and kidney disease and its kernel is used as appetizer, tonic and anti-inflammatory (Bharthi *et al*., 2015**).** Waterchestnut is crunchy and sweet with mild flavor. Waterchestnut had excellent properties to promote salivation and quenches thirst. It is effective to control loose motion and it's a food for being healthy lifestyle. Waterchestnut is rich in nutrients and low in calories. Having detoxifying property, it is beneficial for the people that suffer from Jaundice. In the form of raw or in juice, it helps alleviate the problem of bad appetite in children as well as in adult also (Rani *et al.*, 2016), The kernel of waterchestnut is delicious to eat and contain many essential minerals. Waterchestnut is useful to make appetizer, astringent and coolant (Bhatiwal and Jain, 2012). Flour of waterchestnut had been consumed during fast in many Indian religious rituals. Waterchestnut had high in protein, carbohydrate, flavonoid content and antioxidative properties. Thus, acetone extract of waterchestnut fruit higher in phenolic and antioxidant property (Mann *et al.*, 2012). It consumed after steaming when the outer cover get soften and kernel of waterchestnut is cooked. (Walde and Misra, 2016). The present study was planned with the objective to ooptimization of method for preparation of water chestnut flour, to evaluate its biochemical & nutritional properties and preparation of dosa from water chestnut flour.

II. Methodology

The present study was conducted in Laboratory of Food Science, Department of Food & Biotechnology, Jayoti Vidyapeeth Women's University, Jaipur.

III. Procurement of Raw Materials

The required materials *i.e.* waterchestnut, rice, black gram, fenugreek seeds, spices, peanut, coconut, refined oil and vegetables etc. was collected from local market of Jaipur city, India. 1 kg fruits of waterchestnut were washed thoroughly with tap water, and then remove excess water and after removing the peel of waterchestnut, cut the fruits into slices and then dipped in to the KMS solution (0.5%). After cutting different methods were adopted for drying the water chestnut.

1. Commercial Dried Waterchestnut
2. Sun Dried Waterchestnut
3. Hot Air Oven Dried Waterchstnut
4. Shade Dried Waterchestnut
5. Microwave Dried Waterchestnut
6. Tray Dried Waterchestnut

Dried waterchestnut slices were grinded to make the flour. The flour incorporated in different ratio for preparing dosa. For preparing batter, rice, black gram and fenugreek seeds were soaked for 6 hours and then make the fine paste. The paste was kept as such for

10 hours for fermentation.

IV. Biochemical and Nutritional Analysis of Waterchestnut Flour:

a. Proximate Analysis

The proximate analysis of waterchestut flour viz; crude ash, crude fat, crude fiber and crude protein were determined according to the methods described by AOAC (2007). The protein content of waterchestut flour was estimated by using MicroKjeldahl method to get nitrogen content. The nitrogen conversion factor used for crude protein calculation was 6.25. The crude fat (%) was determined by soxhlet extraction method. The carbohydrate content (%) was calculated by subtracting the contents of crude ash, fat, fiber and protein from 100% of dry matter.

b. Mineral Content Estimation

waterchestut flour samples were dry-ashed according to AOAC (2007) for mineral estimation.The dry ashing of the samples was done in muffle furnace at 480 ºC.

i. ***Calcium (Ca)*:** The aliquots were analyzed for calcium (Ca) estimation, by using atomic absorption spectrophotometer.

ii. ***Potassium (K)*:** Potassium (K) content was determined according to AOAC (2007) by flame photometer.

V. Antioxidant Activity Of Waterchestnut Flour

a. Preparation of waterchestnut extract

Each sample (0.3 g) was dissolved in 20 ml of 70% methanol. Then stirring for 2 h by a magnetic stirrer, after stirring it was centrifuged at 3500 rpm for 10 min. The supernatant of sample was filtered and stored at -18 ºC. The supernatant was used for antioxidant activity.

b. *Total phenolic content*

Total phenolic content was evaluated by Folin–Ciocalteu's spectrophotometric method, with some modifications (Singleton et al., 1999; Jan et al., 2015). Extract was take into a test tube containing 1 mL of ethanol, then add 0.5 mL of Folin- Ciocalteu reagent, left for 5 min. 1 mL Na_2CO_3 5% was divortexed and left for 60 min in the dark. The sample was homogenized before to measure its absorbance, the absorbance measured at 725 nm. The results were expressed as Gallic acid equivalents (gGAE/1000 g) of sample.

c. Antioxidant content (DPPH [2,2-diphenyl-1-picrylhydrazyl] scavenging activity)

DPPH scavenging activity of the extracts was determined by Baba *et al.* (2014). Incubate the prepared samples for 30 min & than measured the absorbance at 517 nm. Lower absorbance of the reaction mixture indicates higher free radical scavenging activity. Percentage inhibition was calculated by using the formulae.

$$\% \text{ inhibition } ¼ = [A_{\text{Control } 517} - A_{\text{Sample } 517}/A_{\text{Control } 517}] \times 100$$

Where, $A_{control517}$ is the absorbance of the control and $A_{sample517}$ is the absorbance of the extract.

VI. Preparation of Dosa by Waterchestut Flour

Dosa ingredients & batter preparation

Measured the ingredients rice (500 g), black grams (100 g), fenugreek seeds (30 g), waterchestnut flour (5g, 10g, 15g and 20 g) and salt (according to taste). Washed and then soaked all the ingredients separately (rice, black gram, fenugreek seeds) for 6 hours. Removed the water and ground finely. Kept the batter for 10 hours for fermentation. Add waterchestnut flour, salt and mixed it well. Add sample amount of water till batter turned into pouring consistency.

On the other side, the dosa stuffing was prepared. The ingredients of dosa stuffing were used potatoes, green peas, tomatoes, onion, salt, turmeric, mustard seeds, oil. For making dosa stuffing, heated the pan and put a spoon of oil, the put all ingredient (chopped onion, mustard seeds, salt (to taste), turmeric) into heated oil & fried to golden brown. Added tomato puree & peas, stir 1-2 minutes than added the mashed potato into it. Heated 5 minute the left a side.

Heated the pan and greased with oil. Pour the batter into the pan. Spread batter in circle with back of ladle. Cooked one side and spread the stuffing evenly on an other side of dosa. The batter crackled and turned into golden colour. Removed the dosa with the help of ladle. Served dosa with peanut chutney.

VII. Control And Four Experimental Treatments Were Prepared As Follows

T_0 (Control): In this, the standardized recipe was followed to prepare the products without any incorporation of waterchestnut flour.
T_1 (5%, 95%): In this treatment, 5% Waterchestnut flour and 95% dosa batter to prepared products.
T_2 (10%, 90%): In this treatment, 10% Waterchestnut flour and 90% dosa batter to prepared products.
T_3 (15%, 85%): In this treatment, 15% Waterchestnut flour and 85% dosa batter to prepared products.
T_4 (20%, 80%): In this treatment, 20% percent Waterchestnut flour and 80% dosa batter to prepared products.

VIII. Replications

All the five variants (with control) of dosa batter respectively were replicated four times to get average values.

IX. Organoleptic Evaluation

Sensory evaluation of the dosa for acceptability was done by 15 semi-trained & trained panel members of judges. Colour, Appearance, Texture, Flavor, Taste and after taste were evaluated using the nine points hedonic scale base score card. (Srilakshmi, 2003). The scoring scale was: 1 (Dislike extremely), 2 (Dislike very much), 3 (Dislike moderate), 4 (Dislike slightly), 5 (Neither dislike nor acceptable), 6 (Slightly acceptable), 7 (Moderately acceptable), 8 (Highly acceptable) and 9 (Extremly acceptable). The mean & SD of 15 evaluations was reported.

X. Statistical Analysis

Experiments were performed in triplicates. The data was analyzed using one way analysis of variance (ANOVA) by SPSS (version 21).

XI. Results & Discussion

a. Biochemical & nutritional analysis of waterchestnut flour

i. Proximate content

The biochemical & nutritional composition of waterchestnut flour is presented in Table 1(a) & 1(b). All the samples (CDF, HDF, SHDF, SDF, MDF and TDF) of differently dried waterchestnut flour were 100g. The table 1(a) revealed that the moisture was highest 11.02 g in SDF (Sun Dried Flour) variant while the lowest was in MDF (6.24 g). The protein content was highest 14.0 g in HDF (Hot air oven Dried Flour) as compared to the other treatments. These values were higher than the results reported by Ahmed et al. (2016) and Singh et al. (2011). The variation in the protein content of waterchestnut flour could be attributed to different drying processing and environmental conditions. The fat content was highest 3.44 g in SDF (Sun Dried Flour) while lowest varient of fat was TDF (2.18 g). The total ash content was TDF (Tray Dried Flour) more accepted 3.56 g to other sample while lowest variant was CDF. Similar results were also reported by Bala et al. (2015) & Shafi et al. (2016) for water chestnut. Crude fibre of waterchesnut flour was highest 1.12 g HDF (Hot air oven Dried Flour) to other samples which was lowest to SDF & CDF (0.54 g). Ahmed et al. (2016) also reported similar crude fiber content of waterchestut flour. According to the results the higher carbohydrates content was found in TDF (Tray Dried Flour) *i.e.* 76.88 g then other treatments.

Table 1(a): Nutritional analysis of waterchestnut flour

SI. No.	Parameters	Unit	CDF	HDF	SHDF	SDF	MDF	TDF
Proximate Analysis								
1	Moisture	g/100	9.24	6.36	9.34	11.02	6.24	6.93
2	Protein	g/100	10.98	14.0	10.78	12.42	10.42	10.45
3	Fat	g/100	2.38	2.38	2.96	3.44	2.44	2.18
4	Total Ash	g/100	2.56	3.51	3.39	2.93	2.80	3.56
5	Crude Fiber	g/100	0.54	1.12	0.66	0.54	0.64	0.60
6	Carbohydrates	g/100	74.84	73.75	73.53	70.19	74.10	76.88
Mineral Estimation								
7	Calcium	mg/100	1277.66	1871.09	1226.28	1298.64	1271.09	1629.60
8	Potassium	mg/100	86.56	94.06	86.37	89.26	86.26	99.49

ii. Mineral Estimation

The mineral content of the waterchestnut flour samples are presented in Table 1(a). waterchestnut flour contained significantly higher amounts of potassium (94.06 mg/100g) and calcium (1871.09 mg/100g). Mir et al. (2015) also reported presence of minerals such as potassium, phosphorus and magnesium in water chestnut. Incorporation of waterchestnut flour in our daily diet can help to achieve the recommended daily allowance of potassium & calcium required for proper functioning of the body. Mann et al. (2012) also found that *Trapa bispinosa* is rich in potassium (98.2 ppm). Potassium rich diet seems to lower blood pressure and many health benefits. Potassium & calcium are a part of bones which maintaining the cellular water balance and pH regulation in the body (Yellavila et al. 2015).

iii. Antioxidant Activity

The biochemical analysis of waterchestnut flour total phenolic content of HDF (hot air oven dried flour) was higher than the other samples. Antioxidant as dpph and antioxidant activity both were same in all variants of waterchestnut flours. The highest total phenolic content of waterchestnut flour samples were depicted in HDF sample (17.10 mg/100g) & the lowest content 13.61 mg.100g. On the other hand, the higher antioxidant content was observed in TDF treatment (9.83 %) & the lower antioxidant content was found in HDF sample (6.92 %). The positive correlations were found between phenolic contents and antioxidant activities (Koehnlein et al. 2016). The food digestibility could be increased after heat treatment as it makes active substances that are more easily eluted but the active substances might be degraded after prolonged heat treatment (Su et al., 2014; Ursache et al., 2017). The biological activity directly affects when a great change in the content and composition of the phenolic substances after the foods were digested by the gastrointestinal tract (Papoutsis et al., 2017).

Table 1(b): Antioxidant activity of waterchestut flour.

SI. No.	Parameter / Antioxidant activity	Unit-	CDF-	HDF-	SHDF	SDF	MDF-	TDF
1	Total Phenolic Content	Mg/100	15.43	17.10	14.45	15.70	14.10	13.61
2	Antioxidant as dpph	%	6.92	6.47	7.10	9.0	8.45	9.83

Note- (CDF-Commercial dried flour, HDF-Hot air oven dried flour, SHDF-Shade dried flour, SDF-Sun dried flour, MDT-Microwave dried flour, TDT-Tray dried flour.

Organoleptic Evaluation of Commercial Dried Waterchestnut Flour Dosa

Organoleptic evaluation of dosa for colour/appearance, texture, flavour, taste and after taste was done by 15 semi-trained panel members. Table No. 2 showed the result of organoleptic evaluation of dosa for the different ratio of commercial dried waterchestnut flour. The sample of CDT_4 was better in all parameters. The 15 semi - trained panel members accepted the CDT_4 sample of dosa which was prepared from20% of commercial dried waterchestnut flour and 80% of dosa batter. Control sample (CDT_1) was less acceptable to others which were prepared with 100% of dosa batter. Figure (1) showed the appearance and colour of commerciall dried waterchestnut flour.

Figure (1): Dosa prepared with waterchestnut flour (a) commercial and (b) shade dried variants.

Table (2): Organoleptic Evaluation of Commercial Dried Waterchestnut Flour Dosa.

Sample Name	Color/Appearance	Texture	Flavour	Taste	After Taste	Total
(A) Control	7.1±0.77	7.3±0.90	7.4±0.94	7.5±0.86	7.4±0.87	36.7
(B) CDT_1	7.5±0.63	7.6±0.59	7.7±0.46	7.7±0.68	7.6±0.64	38.1
(C) CDT_2	8±0.54	8.1±0.59	7.8±0.67	7.7±0.56	7.6±0.55	39.2
(D) CDT_3	7.7±0.56	7.5±0.73	7.7±0.68	7.7±0.78	7.5±0.70	38.1
(E) CDT_4	7.9±0.68	7.9±0.75	8.1±0.74	8±0.83	8±0.77	39.9

Note - ± (standard daviation)

The Table No.3 showed the result of sensory analysis which was done by semi-trained panel members. Dosa, which made up with different dosa variants. The sample of $ShDT_4$ was best in all parameters such as color/appearance, texture, flavor, taste and after taste. The $ShDT_4$ sample of dosa was accepted by panel members which was prepared from 20% of shade dried waterchestnut flour and 80% of dosa batter. In this table $ShDT_2$ was not much acceptable to other samples of dosa variant which made up with different ratio of waterchestnut flour and dosa batter in each sample.

Table (3): Organoleptic Evaluation of Shade Dried Waterchestnut Flour Dosa.

Sample Name	Color/ Appearance	Texture	Flavour	Taste	After Taste	Total
(A) Control	7.6±0.9	7.5±0.72	7.6±0.74	7.6±0.71	7.5±0.66	37.8
(B) $ShDT_1$	7.4±0.70	7.4±0.66	7.7±0.56	7.6±0.59	7.5±0.62	37.6
(C) $ShDT_2$	7.6±0.67	7.8±0.64	7.6±0.56	7.6±0.56	7.5±0.73	38.1
(D) $ShDT_3$	8.0±0.5	7.8±0.87	8.0±0.72	7.5±0.67	7.7±0.75	39
(E) $ShDT_4$	8.2±0.75	8.2±0.81	8.0±1.02	8.0±1.00	8.0±1.00	40.4

On the basis of findings the table no.4 concluded that the result of sensory analysis which was done by panel members for dosa which made up with different dosa variants. These samples contained different ratio of dosa batter 95%, 90%, 85%, 80% and waterchestnut flour 5%, 10%, 15%, 20% to making dosa. The sample of MDT_2 was better in all parameters. The MDT_2 sample of dosa was accepted by panel members which was prepared from 10 % of microwave dried waterchestnut flour and 90% of dosa batter. Control sample was least acceptable by the panel members.

Table (4): Organoleptic Evaluation of Microwave Dried Waterchestnut Flour Dosa.

Sample Name	Color/ Appearance	Texture	Flavour	Taste	After Taste	Total
(A)Control	7.00±1.10	7.05±1.06	7.27±1.06	7.32±1.17	7.36±1.12	36.00
(B)MDT_1	7.32±0.68	7.36±0.64	7.450.82	7.32±0.68	7.27±0.88	36.73
(C)MDT_2	8.05±0.65	8.00±0.67	8.05±0.52	7.91±0.77	7.73±0.72	39.73
(D)MDT_3	7.50±0.87	7.59±0.83	7.45±1.17	7.32±1.15	7.36±1.00	37.23

(E)MDT$_4$	7.32±1.06	7.18±1.23	7.45±1.31	7.41±1.07	7.45±0.93	36.82

The Table No.5 showed the result of sensory analysis which was done by semi-trained panel members. Dosa prepared with different dosa variants by addition of differently dried waterchestnut flour. These samples contained different ratio of dosa batter and waterchestnut flour to making dosa. The sample of HADT$_4$ was better in color/appearance, texture, flavor,taste and after taste. The HADT$_4$ sample of dosa was accepted by panel members which was prepared from 20 % of hot air oven dried waterchestnut flour and 80% of dosa batter and control sample was not much accepted by panel members which was prepared with 100% of dosa batter.

Table (5): Organoleptic Evaluation of Hot Air Oven Dried Waterchestnut Flour Dosa.

Sample Name	Color/ Appearance	Texture	Flavour	Taste	After Taste	Total
(A)Control	6.8±0.98	6.9±0.83	7±0.63	7.04±0.65	7.09±0.49	34.8
(B)HADT$_1$	6.8±0.89	7±0.94	7.2±0.75	7.2±0.64	7.2±0.68	35.6
(C)HADT$_2$	7.3±0.95	7.1±0.80	7.2±0.93	7.5±1.06	7.6±0.95	36.9
(D)HADT$_3$	8±0.86	7.7±0.78	7.6±0.55	7.7±0.68	7.7±0.68	38.8
(E)HADT4	8.1±0.55	8.2±0.51	8.1±0.74	8.5±0.74	8.2±0.78	41.2

Table No.6 concluded the result of sensory analysis which was done by semi-trained panel members. Dosa which made up with different dosa variants. These samples contained different ratio of dosa batter and waterchestnut flour to making dosa, The SDT$_4$ sample of dosa was accepted by panel members which was prepared from 20 % of sun dried waterchestnut flour and 80% of dosa batter. Control sample of dosa was not much accepted by panel members. This sample (control) was made up with 100% of dosa batter.

Table (6): Organoleptic Evaluation of Sun Dried Water chestnut Flour Dosa.

Sample Name	Color/Appearance	Texture	Flavour	Taste	After Taste	Total
(A)Control	7.27±0.88	7.05±0.79	6.95±0.93	7.05±0.93	7.14±1.07	35.45
(B)SDT$_1$	7.27±0.68	7.32±0.75	7.41±0.63	7.50±0.81	7.50±0.81	37.00
(C)SDT$_2$	7.59±0.86	7.55±0.65	7.77±0.68	7.91±0.44	7.95±0.57	38.77
(D)SDT$_3$	7.73±1.06	7.77±1.19	7.91±0.89	7.68±1.12	7.77±0.79	38.86
(E)SDT$_4$	7.91±0.80	7.95±1.01	7.91±0.80	7.91±0.89	8.09±0.97	39.77

Table No.7 showed the result of sensory analysis which was done by 15 semi-trained panel members. These samples contained different ratio of waterchestnut flour for making dosa. The sample of TDT$_4$ was highly acceptable in all parameters. TDT$_4$ sample of dosa was more accepted by panel members which was prepared from 20% of tray dried waterchestnut flour and 80% of dosa batter. The dosa become darker significantly in colour/appearance due to increasing level of waterchestnut flour.

Table (7): Organoleptic Evaluation of Tray Dried Waterchestnut Flour Dosa

Sample Name	Color/ Appearance	Texture	Flavour	Taste	After Taste	Total
(A)Control	7.27±0.75	7.23±0.85	7.73±0.41	7.68±0.46	7.68±0.46	37.59
(B)TDT$_1$	7.27±0.68	7.32±0.75	7.41±0.63	7.50±0.81	7.50±0.81	37.00
(C)TDT$_2$	7.59±0.86	7.55±0.65	7.77±0.68	7.91±0.44	7.95±0.57	38.77
(D)TDT$_3$	7.27±0.88	7.05±0.79	6.95±0.93	7.05±0.93	7.14±1.07	35.45
(E)TDT$_4$	7.91±0.80	7.95±1.01	7.91±0.80	7.91±0.89	8.09±0.97	39.77

XII. Conclusion

On the basis of findings conclude that the T$_4$ which was 80:20 ratio of flours could be considered best for both point of view (nutritionally and sensory). Commercial dried, Sun dried, Shade dried, Tray dried and Hot Air Oven dried sample formulation was comparatively best and more accepted for developed dosa product while Microwave dried sample was not much accepted. Different ratio 95%, 90%, 85%, 80% of dosa batter replaced with prepared waterchestnut flour 5%, 10%, 15%, 20% which made up with various drying techniques. The organoleptic evaluation shows that the 80:20 ratio of developed food product dosa was best in all the attributes. The dosa prepared with waterchestnut flour can be considered as therapeutic diet for healthy lifestyle.

XIII. References

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