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A study on incorporation of water chestnut (*Eleocharis dulcis*) flour and barnyard millet (*Echinochloa esculenta*) flour in samosa sheets to prepare high-fiber ready to eat samosa

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Abstract
With the aim to prepare high fibre and low gluten ready-to-eat samosa, the refined wheat flour (RWF) used for samosa sheet preparation was fortified with water chestnut flour (WCNF) and barnyard millet flour (BMF), precisely 25% (R_1), 30%(R_2) and 35% (R_3). The effect of incorporation was studied on water used (ml), dough development time (DDT), gluten content, elasticity, stickiness, spread ratio (SR), spreadibility factor (S*f*) and air frying time (AFT) for all samples. The results displayed an increase in the water used in the process from 88 ml to 140 ml with decreased DDT (8.05 ± 0.4 to 7.08 ± 0.2 min) from sample R to R_3 respectively. Gluten formation decreased from 10.26 ± 1.08% in sample R to 4.89 ± 0.89 in R_1 and 2.06 ± 1.02% in R_2 while there was no gluten formation in R_3. Elasticity and stickiness were done on sensorial basis. SR were 3.25, 46.47 and 90.21 & 357.85, S*f* were 64.99, 85.50, 110.73 and 131.35 with AFT at 180 ºC to be 18, 15, 13 and 10 min for sample R, R_1, R_2 & R_3 respectively. Sensory evaluation of product revealed no significant difference (p>0.05) in the sensory attributes due to incorporation of WCNF and BMF as a healthy replacement for high cholesterol and high gluten traditional samosa.

Keywords: Samosa, water chestnut flour, barnyard millet flour, spread ratio, spread factor

Introduction
Samosa is a mouth-watering Indian savoury snack known to every house-hold in India and South Asia. It is prepared by stuffing conical shaped refined wheat flour sheet casings followed by deep frying in edible oils. The stuffing/filling of samosa varies with the choice or climate/region from potatoes to vegetable filling, fruit filling (sweet samosa) (Guiné, 2012) [5], paneer stuffing and sometimes split Bengal gram (Urad) and Chickpea (Channa) pulses (dal), etc. People love to consume it throughout the year as morning or evening snack but it is a perishable snack with shelf life of three to four days (Raj *et al*., 2017) [9] and the process of its preparation is lengthy and tedious. To overcome the cumbersome effort of preparing it instantly, ready to eat samosa with increased shelf-life, stuffed with Bengal gram and chickpea gained the attention. Since then, lot of efforts are put to make it healthier and more nutritious, by standardization of ingredients and optimization of process with value addition to prepare high-fibre and low gluten samosa.
Keeping in view, the present investigation was designed to replace the portion of refined wheat flour (RWF) with water chestnut flour (WCNF) and barnyard millet flour (BMF). WCNF is rich vitamins and minerals like calcium and iron (Singh *et al*., 2010) [13] (Gupta & Awasthi, 2021) [6] while BMF is good source of protein, carbohydrate and fibre. BMF undergo formation of higher amounts of resistant starches due to high degree of retrogradation of amylases (Rao *et al*., 2017) [10] that plays a significant role as prebiotics in our diet thereby enriching our gut micro flora. Hence the incorporation of WCNF and BMF into samosa sheets with reduced quantity of RWF could be healthier approach for making samosa.).

Materials and Methods
Materials
Refined wheat flour (maida), water chest nut flour, barnyard millet flour and split chick pea were purchased from the local market of Jhansi, India. Spices like red chilli, turmeric powder, coriander powder, dry mango powder, garam masala, fennel seeds, carrom seeds, cumin seeds, asafoetida and salt and refined soyabean oil (Fortune brand) were obtained

from the grocery shop at a local market in Jhansi, India.
The studies were carried out in the Food development Lab of Institute of Food Technology department, Bundelkhand University, Jhansi.

Methods

Preparation of Samosa

To prepare samosa sheet and samosa, the recipe taken was from Shalini, 2012 [12] with little modifications (Fig. 1). RWF, WCNF, BMF, salt, oil and carrom seeds were mixed properly in a food processor (Glen SA 4052 FP 700W, Ireland) and water was added slowly to make a smooth non-sticky dough. Kneading time was monitored using a stopwatch starting from the time water was added to the flour and the kneading started in the food processor. From the prepared dough, balls were made and rolled into circular sheet with the help of rolling pin having thickness of approximately 3 mm. The sheets made were kept to rest for 5min at room temperature so that the wet surface was dried (Shalini, 2012) [12]. The sheets were folded into conical shape (triangular) which were filled with chick pea stuffing.
Chick pea stuffing: Split chick peas (chana dal) was soaked in water for 2 hrs. Dal was washed and grinded coarsely in the grinder (mixer). The coarse paste was then fried in little oil with the spices like cumin seeds, fennel seeds, asafoetida, turmeric, red chilli, coriander powder, garam masala and salt and the mixture was cooked for 2 min.
Stuffed conical shape samosa sheets were sealed by applying pressure through fingers and air frying was done in Pigeon brand Air fryer of model no.12044 (India) at temperature 180 ˚C till the samosa turned golden brown.

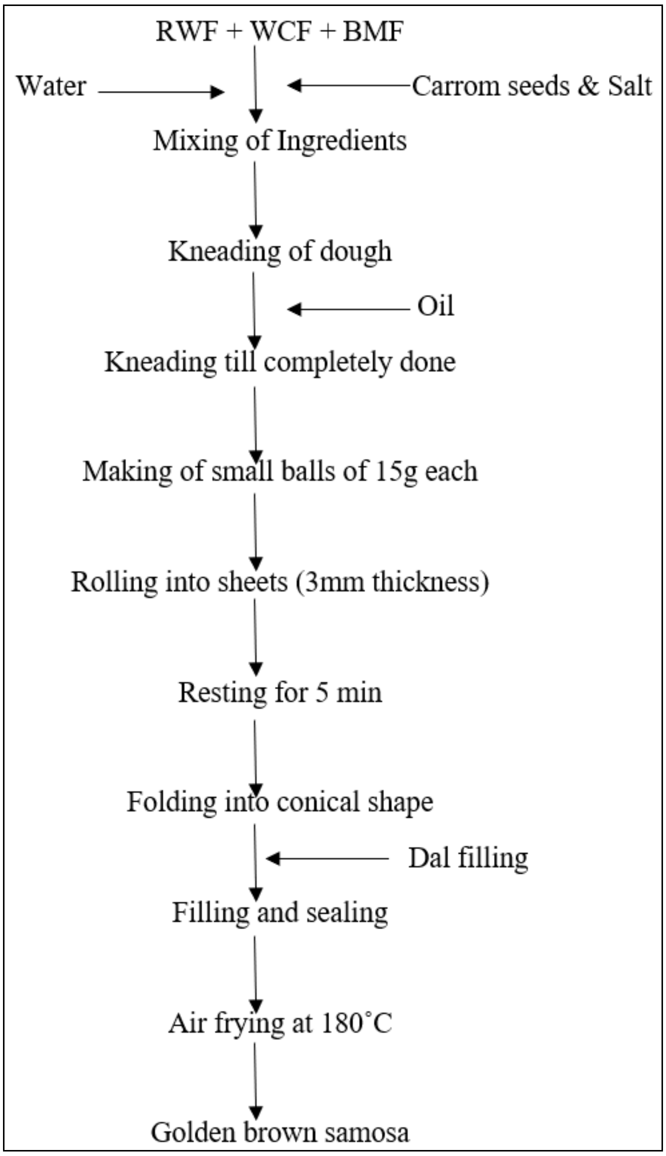

Fig 1: Flow-chart of samosa preparation

Flour analysis

The moisture content, ash content, protein, carbohydrate, crude fibre and dry gluten were determined by AACC method (1976, 2006) and AOAC method (1975, 2006).

Standardization of samosa sheet flour

The three flours RWF, WCNF and BMF were taken in different proportions as described and all other ingredients constant like spices, oil, water and salt were kept constant. Total weight of each sample flour taken was 200 g.

Sample R→ 100% RWF
R_1→ 50% RWF + 25% WCNF + 25% BMF
R_2→40% RWF + 30% W CNF + 30% BMF
R_3→ 30% RWF + 35% WCNF + 35% BMF

Dough Development

Kneading time is very important in making quality dough as it helps in gluten formation and thus effects the textural properties of the product. Kneading causes gluten strands to get stronger and longer. According to (Canja *et al*., 2014) [1], insufficient kneaded dough and excessive kneaded dough both effects the dough quality. The mixing and kneading time was estimated for all the samples (R, R_1, R_2 and R_3). Measured amount of water was used for kneading in a food processor carried out till the smooth texture was obtained and time in minutes (min) was noted for each sample.

Physical properties of Dough

Elasticity

The elasticity of the dough samples was rated based upon the sensorial analysis through the experience of the dough maker (researcher) and scores were given on a scale of 0-5, where 0 means non-elastic and 5 means very-elastic.

Stickiness

The stickiness (making dough kneading difficult) was also evaluated by sensorial analysis experienced by the dough maker based on the rating scale followed in scoring the property of elasticity, on a scale of 0-5, where 0 means non-sticky and 5 means very-sticky.

Spread Ratio (SR) and Spreadibility Factor (S*f*) of samosa sheet

To determine the spread ratio, dough balls (15 g each) were prepared, placed between two glass slides and a constant weight of 1000 g was placed upon the dough ball samples sandwiched between the glass slides for 30 s. The width (W) and height (H) was measured using a vernier calliper and the spread ratio was calculated using the formula W/H according to the method followed by (Dogan *et al*., 2010) [3], where Width was taken as Diameter (D) and Height as Thickness (T) (Sawarsathi *et al*., 2018) [11]. Spreadibilty Factor (S*f*) was calculated using formula S*f* =A/W; where Area (A) = πr^2 (mm^2) and Weight (W) = measured weight (g) (Deuschle *et al*., 2015) [2].

Gluten Content

All four samples (R, R_1, R_2 and R_3) were measured for gluten content as per the AOAC method (1975).

Air Frying time (AFT)

Frying process is an important part in savoury preparation but deep fat frying results in oily and unhealthy products. In order to switch to healthier alternatives, frying was done in an air fryer (Pigeon Super model no.12044, India) after coating the samosa with a negligible amount of frying oil using an oil brush. AFT was calculated at a constant temperature of 180 ˚C from the time when samosa were kept in the air fryer till the samosa turned golden brown in colour.

Sensory Evaluation

Sensory evaluation of the product was done on the basis of 9-point hedonic scale with 10

trained panellists. The average score of panellists was taken and the highest score sample was selected. These panellists are from the food technology background and faculty members in Bundelkhand University, Jhansi. They have given their written consent to take part in the investigation.

Statistical analysis

The impact of incorporation on RWF with blends of WCNF and BMF was analysed by measuring correlation using MS Excel (Windows 2013). SD was computed for all the data obtained and one way ANOVA test was done for establishing the significant differences at p≤0.05 levels in the given samples.

Result and Discussion

Analysis of flour

The proximate analysis of flour RWF, WCNF and BMF given in Table 1, the moisture content was highest in RWF, i.e., 13.54 ± 0.08% as compared to other flours where the values were 11.20 ± 0.07% and 10.33 ± 0.04% and the ash content was shown highest in WCNF 0.911 ± 0.02% than to RWF (0.48 ± 0.02%) and BMF (0.144 ± 0.02) as assumed by (Singh *et al*., 2010) [13] (Gupta & Awasthi, 2021) [6].

Table 1: Proximate analysis of the given flour samples.

S. No.	Parameters	RWF (% ± SD)	WCNF (% ± SD)	BMF (% ± SD)
1.	Moisture	13.54 ± 0.08	11.20 ± 0.07	10.33 ± 0.04
2.	Ash	0.48 ± 0.02	0.911 ± 0.02	0.144 ± 0.02
3.	Protein	11.02 ± 0.05	1.14 ± 0.04	13.25 ± 0.03
4.	Carbohydrate	74.66 ± 0.07	7.16 ± 0.06	55.15 ± 0.05
5.	Crude fibre	10.4 ± 0.06	3.57 ± 0.04	15.22 ± 0.05
6.	Gluten	10.26 ± 0.20	-	-

*All values are mean ± SD, n=3

Protein content was reported lowest 1.14 ± 0.04% in WCNF as compared to RWF (11.02 ± 0.05%) and BMF (13.25 ± 0.03%). As presumed, the carbohydrate content was highest in RWF 74.66 ± 0.07% followed by BMF 55.15 ± 0.05% and 7.16 ± 0.06% in WCNF. BMF showed highest value of crude fibre (Rao *et al*., 2017) [10] 15.22 ± 0.05% among all three flours. Gluten content was only found present in RWF 10.26 ± 0.20% while WCNF and BMF it was not formed since they are regarded as gluten free flours (Gupta & Awasthi, 2021) [6].

Dough Development

An important parameter of dough development is time (DDT) (Ognean *et al*., 2011) [8]. In Table 2(a) water used (ml) in sample R, R_1, R_2 and R_3 increased revealing the water holding capacity of the samples. As the crude fibre content (Table 1) in the sample increased from R to R_1, R_2 and R_3, the amount of water used to make dough was also increased from 88 ml/200 g to 110 ml/200 g, 125 ml/200 g and 140 ml/200 g. The above findings were supported by (Ognean *et al*., 2011) [8] stating that water binding properties of cereal fibres is high as compared to other fibres. Dough development time (DDT) decreased from 18 min to 15 min, 13 min and 10 min (sample R, R_1, R_2 & R_3) with decrease in the amount of gluten content (10.26 ± 1.08% to 4.82 ± 0.89% and 2.06 ± 1.02%) due to the presence of some soluble compound in the cereal fibre which can act on gluten and decreases the time of gluten formation and hence the dough development time (DDT) was reduced. (Ognean *et al*., 2011) [8] also mentioned the different hydration time for different fibre so the time to completely hydrate dough varied leading to changes in the dough development time (DDT). Sample R_3 reported gluten content below detectable limit therefore considered no gluten formation. This was due to 70% of non-glutenous flour (WCNF & BMF) and 30% RWF.

The elasticity and stickiness of samples were reported inversely proportional in Table 2(a). As we saw (Table 2 (a)), the RWF (sample R) was replaced by WCNF and BMF (sample R_1, R_2 & R_3) the elasticity of the dough decreased due to the decrease in gluten formation in sample R_1, R_2 and R_3 while the stickiness of the dough increased resulting the dough making difficult in sample R_3. In comparison to sample R, the sample R_1 was found to have elasticity score of 3.0 ± 0.4 and stickiness 4.0 ± 0.4 due to decreased amount of gluten (4.89 ± 0.89%) than to the previous sample R (10.26 ± 1.08%). The amount of gluten content in sample R_2 was significantly low and absent in case of sample R_3 which was the reason for low elasticity score and high stickiness score of the dough. The degree of hydration of gluten proteins contributes to the sticky properties of dough (Van Velzen *et al*., 2003) [15].

Table 2 (a): Effect of addition of WCNF and BMT in RWF on various physical factors

Sample	Water used (ml)	Dough development time (DDT) (in min)	Elasticity	Stickiness	Gluten (%)	Air Frying Time (AFT) (in min)
R	88	8.05 ± 0.4	4.5 ± 0.2	2.0 ± 0.4	10.26 ± 1.08	18
R_1	110	7.52 ± 0.3	3.0 ± 0.4	4.0 ± 0.4	4.89 ± 0.89	15
R_2	125	7.20 ±0.4	2.8 ± 0.2	4.3 ± 0.2	2.06 ± 1.02	13
R_3	140	7.08 ±0.2	2.5 ± 0.3	4.5 ± 0.2	NIL	10

*All values are mean ± SD, n=3

Air frying time (AFT) and temperature played a major role in affecting the crispiness of samosa. In Table 2(a) sample R was reported having longest AFT (18min) due to the presence of high glutenous starch while AFT of sample R_3 was reported to be shortest (10min) due to more of non-glutenous starch. (Gazmuri & Bouchon, 2009) [4] reported that low gluten content starch during deep fat frying retains water vapour only if the thickness of disc (dough sheet) was increased. (Nakamura & Ohtsubo, 2010) [7], also mentioned that crispiness was dependent on low gelatinization and fragility of starch during frying.

The decrease in AFT in sample R_1, R_2 and R_3 at the constant temperature of 180 ˚C, may also be due to the early production of dextrin and pyro dextrin in dextrinization of starch in air frying process. Sample R_3 had low glutenous starch which caused early breakdown into dextrin and pyro dextrin, resulting in early browning (non-enzymatic browning) and caramelisation. Since the product is air fried the oil absorption was non-significant, hence excluded from the scope of investigation.

Spread Ratio (SR) and Spreadibility Factor (S*f*) of samosa sheet:

The effect of incorporation of WCNF and BMF on dough spreading ability in sample R, R_1, R_2 and R_3 reported as Spread Ratio (SR) in Table 2 (b) showed abrupt increase in the values with increased in the incorporation of WCNF and BMF. Sample R_3 reported the highest SR value of 357.85 which indicated loss of binding property of flour due to no gluten formation in the sample. Loss of binding property/stretchability caused deformed and fragile samosa sheet with very less holding capacity/stretchability for stuffing. Sample R_2 and sample R_1 reported SR to be 90.21 and 46.47 while SR for sample R was found to be 3.23 indicating highest elasticity due to high gluten content, making the stuffing a task. The SR of R_1 (46.47) indicated good holding capacity of dough, and resulted into ease of dough handling when rolled into sheets. Sultana *et al*., 2014 [14] reported the spread ratio in chapattis enriched with jackfruit seed flour and Bengal gram flour. The Spreadibility factor (S*f*) calculated also indicated the excessive spreadibility of sample R_2 and R_3 responsible for deformed product (Table 2 (b)).

Table 2 (b): Effect of addition of WCNF and BMT in RWF on spread ratio (SR) and Spreadibility factor (S*f*)

Sample	Weight of dough balls (g)	Diameter (D) (mm)	Thickness (T) (mm)	Spread Ratio (SR) = D/T	Spreadibilty Factor (S*f*) = A/W
R	15 g	35.24 ± 0.01	10.91 ± 0.02	3.23	64.99
R_1	15 g	40.43 ± 0.02	0.87 ± 0.01	46.47	85.50
R_2	15 g	46.01 ± 0.01	0.51 ± 0.02	90.21	110.73
R_3	15 g	50.10 ± 0.03	0.14 ± 0.02	357.85	131.35

*Values of D and T are mean ±SD, n=3

Sensory evaluation

The results of sensory evaluation tests are given in Table 3. The results indicated the non-significant effect of variation due to incorporation of flours in the given samples R, R_1, R_2 and R_3. Through ANOVA test, the null hypothesis was accepted which proved the incorporation of WCNF and BMF to RWF do not have significant difference in the samples (R_1, R_2 and R_3) at sensory levels (p>0.05). The average score of sensory attributes ranged from 7.3 ± 0.9 to 8.4 ± 0.5 also pointed out that the product was largely acceptable to the panellists and there was no rejection of samples at any level of sensory analysis. Some non-preferences were made by panellists for sample R_2 and R_3 on overall acceptability attribute (OAA) 7.2 ± 0.5 and 7.8 ± 0.5, the sample R_1 was found very close to sample R (8.2 ± 0.5) having overall acceptability (O.A.A.) attribute 8.0 ± 0.4. The texture and flavour attributes of sample R_1 was in addition better than all the other samples. Starch dextrinization due to dry heat in air frying caused Maillard reaction and early browning in sample.

Table 3: Sensory evaluation.

Sample	Colour	Flavour	Texture	Taste	Overall acceptability
R	8.4 ± 0.5	8.1 ± 0.9	8.0 ± 0.9	8.3 ± 0.6	8.2 ± 0.5
R_1	7.7 ± 0.8	8.1 ± 0.6	8.1 ± 0.7	8.1 ± 0.8	8.0 ± 0.4
R_2	7.3 ± 0.9	7.9 ± 0.6	7.8 ± 0.9	8.2 ± 0.5	7.2 ± 0.5
R_3	7.8 ± 1.0	7.8 ± 0.5	7.8 ± 0.5	8.0 ± 0.7	7.8 ± 0.5

* All values are mean ± SD of ten determinations.

Conclusion

The present investigation was carried out to incorporate value added flours like WCNF and BMF into samosa sheets, thereby replacing a part of RWF with WCNF and BMF, for making samosa more nutritious and healthier. The control sample R (100% RWF) was found to be the best choice in dough development properties and sensory attributes and any incorporation leads to increase or decrease in the palatability. In spite of being the most preferred sample in overall acceptability (OAA), the control sample R was over looked and R_1 was regarded as a better choice both nutritionally and in sensorial aspect. With 50% replacement of RWF with WCNF and BMF, we have fibrous and nutritious samosa.

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References

1. Canja CM, Lupu M, Tăulea G. The influence of kneading time on bread dough quality. Bulletin of the Transilvania University of Brasov, Series II: Forestry, Wood Industry, Agricultural Food Engineering. 2014;7(1):79-84.
2. Deuschle VCKN, Norbert Deuschle RA, Bortoluzzi MR, Athayde ML. Physical chemistry evaluation of stability, spreadability, *in vitro* antioxidant, and photo-protective capacities of topical formulations containing *Calendula officinalis* L. Leaf extract. Brazilian Journal of Pharmaceutical Sciences. 2015;51(1):63-75. https://doi.org/10.1590/S1984-82502015000100007
3. Dogan IS, Yildiz O, Tasan B. Spread and microwave oven baking test for bread making quality. International Journal of Agriculture and Biology. 2010;12(5):697-700.
4. Gazmuri AM, Bouchon P. Analysis of wheat gluten and starch matrices during deep-fat frying. Food Chemistry. 2009;115(3):999-1005. https://doi.org/10.1016/j.foodchem.2009.01.020
5. Guiné RPF. Sweet samosas: A new food product in the Portuguese market. Academic Research International. 2012;2(3):70-81.
6. Gupta A, Awasthi M. Formulation of Water Chestnut Flour and Ragi Flour Biscuits for Celiac Patients and Study on Their Nutritional Attributes and Sensory Evaluation. 2021;8(1):1-5.
7. Nakamura S, Ohtsubo K. Influence of physicochemical properties of rice flour on oil uptake of tempura frying batter. Bioscience, Biotechnology and Biochemistry. 2010;74(12):2484-2489. https://doi.org/10.1271/bbb.100584
8. Ognean C, Ognean M, Neli D. The effect of some commercial fibers on dough rheology. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca – Agriculture. 2011;68(2):372-377. https://doi.org/10.15835/buasvmcn-agr:6585
9. Raj T, Kar JR, Singhal RS. Development of Par-Fried Frozen Samosas and Evaluation of Its Post-Storage Finish Frying and Sensory Quality. Journal of Food Processing and Preservation. 2017;41(4). https://doi.org/10.1111/jfpp.13049
10. Rao DB, Bhaskarachary K, Christina AGD, Devi SG, Tonapi AV. Nutritional and health benefits of beer. In ICAR_Indian Institute of Millets Research, Hyderabad 2017, 320(5), https://doi.org/10.1097/00000441-200011000-00004
11. Sawarsathi D, Renu R, Maloo S. Development and quality evaluation of pumpkin seeds and flaxseeds powder incorporated biscuits. International Journal of Food Science and Nutrition. 2018;3(2):78-83.
12. Shalini A. Preservation of Ready-To-Prepare (RTP) Samosa Sheets. Pakistan Journal of Food Sciences. 2012;22(4):197-205. https://www.researchgate.net/publication/260132550
13. Singh G, Singh S, Jindal N, Deep Singh G, Siingh S, Bawa AS, *et al*. Physico-chemical characteristics and sensory quality of Singhara (*Trapa natans* L.): An Indian water chestnut under commercial and industrial storage conditions. African Journal of Food Science. 2010;4(11):693-702. http://www.academicjournals.org/ajfs
14. Sultana A, Tanver Rahman MR, Islam M, Rahman M, Alim MA. Evaluation of Quality of Chapaties Enriched with Jackfruit Seed Flour and Bengal Gram Flour. IOSR Journal of Environmental Science, Toxicology and Food Technology. 2014;8(5):73-78. https://doi.org/10.9790/2402-08537378
15. Van Velzen EJJ, Van Duynhoven JPM, Pudney P, Weegels PL, Van der Maas JH. Factors associated with dough stickiness as sensed by attenuated total reflectance infrared spectroscopy. Cereal Chemistry. 2003;80(4):378-382. https://doi.org/10.1094/CCHEM.2003.80.4.378