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Enrichment of RTE snack (*Bhujia*) with Tomato pomace powder as a functional ingredient

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Abstract
Snacks are an important aspect of diet and healthy snacking is the need of the hour. Tomato pomace is a by-product of the tomato processing industry and a very nutritious substance, and it was utilized in an Indian snack, *bhujia* and studies were conducted to study the effect of tomato pomace powder in the *bhujia* formulations at a level varying from 0 to 12.5%. It was found that its addition up to 5% gave a product of high acceptability in aspects of its sensorial properties. The product obtained also gave increased yields as compared to the control sample where no tomato pomace powder was added. The compositional profile of this product shows it to be a rich source of protein (16.52%), fat (20.8%), fiber (3.40%), antioxidant activity (38.5%) and an energy value of 485.32 kcal/100g. Hence, the tomato pomace powder can be effectively utilized and at the same time get a popular snack with improved nutritional benefits.

Keywords: By-product utilization, tomato pomace, RTE snack, indigenous products

Introduction
Tomato (*Solanum lycopersicum*) holds a crucial place in India's agricultural landscape as one of the prominent vegetable crops. India's standing as one of the world's leading producers of tomatoes underscores its significance Gupta *et al*., 2020) [1]. This versatile crop caters to both domestic consumption and export demands, contributing substantially to the country's economy (Rai *et al*., 2019) [2]. The processing of tomatoes is a pivotal practice that adds value to the harvested produceby reducing post-harvest losses and creating various value-added products like purees, ketchup, sauces, and canned goods, meeting diverse consumer preferences (Rastogi *et al*., 2017) [3]. This processing not only reduces post-harvest losses but also enhances shelf life, thereby promoting year-round availability (Bhise *et al*., 2018) [4]. The processed tomato products industry has witnessed remarkable growth due to urbanization and changing lifestyles (Mishra *et al*., 2018) [5].
Tomato pomace, comprising skins, seeds, and residual pulp, is generated as a byproduct during tomato processing. It is partially utilized in animal feeds or as landfill causing great environment concerns (Silva *et al*., 2018) [6]. This byproduct, often considered waste, exhibits substantial nutritional potential. Rich in dietary fiber, antioxidants, vitamins, and minerals, tomato pomace has garnered attention for its utilization in various applications (Jaiswal and Gupta, 2017) [7]. This also helps in lowering wastes as well as adding more economic value to the tomato crop.
In this contemporary era, snacks have now emerged as an essential part of any eating regimen and biting right into a wholesome snack serves the function of comfort and nutrition. The snack ought to serve the twin motive of being capable of being indulged in addition to offering wholesome health for wider acceptance (Rehal *et al*., 2022) [8]. The traditional snacks are popular accompaniment to the morning and evening tea, social gatherings etc. The focus should be to keep these traditional snacks wholesome and with this objective as well as for the sustainable utilization of tomato pomace powder, *bhujia*, which is made with black chickpea powder was enriched with tomato pomace at various levels and evaluated further.

Materials and Methods
The Gram flour (Besan), salt, chili powder, cumin powder and refined oil were purchased from a local market. Fresh Tomato pomace was sourced from Food Industry Business Incubation center, PAU, Ludhiana. After that, it was dried in mechanical drying equipment –tray dryer at a temperature of 50 ℃+2 ℃ for 48 hours.

Further, it was milled in a vegetable mixer and grinder, sieved in sieve for uniform particles of Tomato pomace powder (TPP) and packed in polyethylene pouches. Then, it was stored safely at temperature of 4 ℃±2 ℃ till further usage.

Table 1: Formulations for the preparation of *bhujia*

Sample	TPP (g)	Gram flour (g)	Salt (g)	Cumin (g)	Chili powder (g)	Water (ml)	Final product (g)
A	0	100	4	0.8	1.6	42	73.5
B	2.5	97.5	4	0.8	1.6	43	105.45
C	5.0	95	4	0.8	1.6	44.5	118.35
D	7.5	92.5	4	0.8	1.6	55	120.44
E	10	90	4	0.8	1.6	58	126.0
F	12.5	87.5	4	0.8	1.6	60	132.5

The value-added product *Bhujia* was prepared using manual extruding equipment (hand-held). Different variations were prepared by replacing gram flour with tomato pomace powder. All the ingredients were firstly weighed before preparation as per the formulation mentioned in (Table 1). All the ingredients after weighing were collected in a bowl and mixed together and dough was prepared by adding required amount of water to get pliable dough. The dough was formed into a ball and put in to the *bhujia* making equipment. Before adding the dough into it, the equipment was greased with a small quantity of oil so that a mixture flows easily from the perforations in equipment while rotating it manually. The *Bhujia* frying was done at a temperature of 170 ℃ for about 5-6 min. The fried *Bhujia* was placed for cooling at an ambient temperature for about 15-20 min. The cooled product was weighed and packed in LDPE pouches and stored at room temperature.

Sensory evaluation of the prepared product was conducted by a semi-trained panel using 9-point hedonic scale and rated the samples on a scale of 9 to 1 as liked extremely to disliked extremely for its sensory parameters like appearance, flavor, taste, texture and overall acceptability. The formulation with maximum overall acceptability was taken up for further analysis.

Color of the samples was analysed objectively in terms of L*, a* and b* values where L* measures lightness ranging from black (L = 0) to white (L = 100), a* measures red (+) or green (-) and b* measures yellow (-) or blue (-) using Color Flex metre (Hunter Lab Color Flex, Hunter Associates Inc., USA. The L*, a* and b* values were used to compute hue angle and chroma as per Rehal *et al*. [8]. Proximate analysis of the samples; moisture, protein, fat, ash and fiber content were determined as per the standard protocols (AOAC). Total carbohydrates andthe energy content in kcal/100g were calculated as per Rehal *et al*. [9]. The water activity was determined using a digital water activity meter (Aqualab PAWKIT, DECAGON Devices, Inc., USA). The antioxidant activity of the samples was evaluated by DPPH assay where an extract of the sample was prepared by refluxing twice with 80% acidified methanol for 3 h. The pooled extracts were centrifuged at 1600xg for 10 mins (Sorvall ST 16R, Thermo Fischer Scientific, Germany), volume made up with aqueous methanol and these extracts were stored in amber bottles at 4±1 ℃ till further analysis (Herrara-Balandrano *et al*.). For the statistical analysis, the experiment was replicated three times and thedata generated was analyzed by statistical methods of one way ANOVA.

Results and Discussion

The sensory analysis of the *Bhujia* prepared by the supplementation of different amounts of TPP was performed and the results are given under table 2.

Table 2: Effect of supplementation of TPP on the sensory values of the RTE snack, *bhujia*

Sample	Color	Flavor	Taste	Texture	Overall acceptability
A	8.4±0.22	8.7±0.19	8.6±0.17	8.6±0.11	8.57±0.11
B	8.2±0.13	8.6±0.07	8.4±0.11	8.4±0.15	8.40±0.15
C	8.2±0.18	8.6±0.14	8.5±0.13	8.3±0.16	8.40±0.18
D	8.0±0.21	8.1±0.16	7.5±0.16	7.4±0.20	7.75±0.19
E	7.6±0.14	7.8±0.11	7.3±0.20	7.1±0.18	7.45±0.11
F	6.9±0.11	6.9±0.14	6.8±0.11	6.5±0.14	6.78±0.09

It was seen that the colour of the control got maximum score which followed a decreasing trend as the amount of the TPP increased from 0 to 12.5%. This was also the trend for the other sensory attributes like flavor, taste and texture. The texture shows the continuous reduction with the increase in the TPP in the formulation which might be due to the high fibre content of the TPP which makes the *bhujia* friable and less crisp. The score for taste attribute got higher scores at 5% level due to the tangy taste given by the addition of TPP but as the supplementation level of the TPP is increasing in other formulations, there is a decrease in the scores of taste parameter due to slight bitterness in the final product. The supplementation up to 5% with TPP received maximum score for the over acceptability after the control sample showing good acceptability of the *bhujia* with 5% of TPP and this formulation was chosen for further studies. The work done by Malemnganbi C C and Singh N (2021) [10] on the *aloo bhujia* made with 5% moringa leaf powder also showed good acceptability of 7.9 in the studies conducted by them.

The color values in the terms of L*, a* and b* values are given under table 3. It was observed that the increase addition of TPP in the samples resulted in the darkening of the product as evident from the decreasing L* values. The lower L* values of extruded snacks with higher addition of tomato poeder was also reported by Wojtowicz *et al*. (2018) [11]. The a* values on the other hand showed an constant increase with the increasing percentages of TPP in the samples. This might be attributed to the presence of lycopene in the TPP which is a red coloured, fat-soluble carotenoid present in good amounts in tomatoes. Chroma represents the color's strength or saturation; hence the higher value of the control sample denotes its more vibrant colour which decreases with the increase in TPP in other samples.

Table 3: Color values of TPP and the various *bhujia* prepared by different formulations

Sample	L*	a*	b*	Hue	Chroma
TPP	55.46	17.33	21.62	51.29	27.70
A	58.21	9.77	23.55	67.47	25.50
B	52.00	6.27	21.12	73.46	22.03
C	46.84	7.86	16.22	64.14	18.02
D	44.32	12.44	13.50	47.34	18.36
E	42.11	15.10	12.11	38.73	19.36
F	38.64	15.76	10.36	33.34	18.86

Fig 1: The *bhujia* samples prepared from the different formulations (A-F)

The figure 1 shows pictures of the bhujia obtained by preparing the product from different formulations while figure 2 shows the final yield of the *bhujia* obtained when prepared by following the procedure as listed in material and method section. It was seen that the yield of the *bhujia* increased as the percent supplementation of TPP is increasing in the samples. It is pertinent to mention that the amount of water added to make pliable dough increased as the TPP amount increased in the formulations. This might be due to the high amount of fiber present in the TPP as reported under table 4 which has the inherent capacity to hold more water hence the addition of TPP helps in improving the yield of the final product as well.

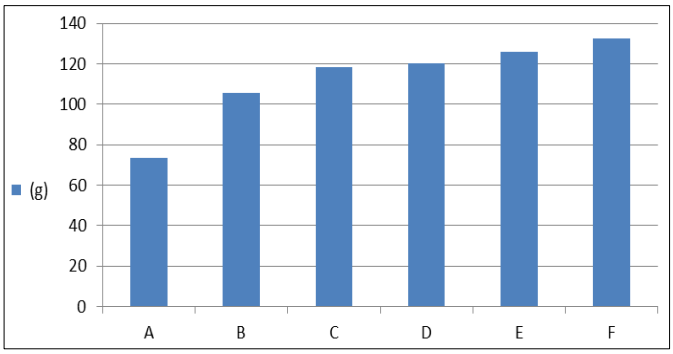

Fig 2: Yield of the Bhujia made with different formulations of Tomato Pomace Powder

The table 4 tabulates the proximate composition, antioxidant activity and the water activity of the TPP and the *bhujia* obtained with 5% supplementation of TPP as it received highest overall sensory scores after the control sample.

Table 4: Characteristics of tomato pomace powder incorporated snack and tomato pomace powder

Parameter	*Bhujia* with 5% TPP (sample C)	Tomato Pomace Powder (TPP)
Moisture content %	2.37±0.17	5.56±0.20
Crude Fat %	20.8±1.36	8.77±0.91
Crude Protein %	16.52±0.98	13.65±0.89
Ash %	2.3±0.11	4.22±0.13
Crude fiber %	3.40±0.06	37.23±1.23
Carbohydrates %	58.01±1.56	30.57±1.52
Energy kcal/100g	485.32±2.56	255.81±2.48
Antioxidant activity%	38.5±1.47	48.23±1.82
Water activity	0.46±0.002	0.65±0.001

The analysis of *bhujia* having 5% TPP for its proximate composition shows that it had a high fat percent of 20.8 which resulted in a higher energy value of the product, while at the same time, appreciable amount of protein can also be obtained from this product. The antioxidant activity of 38.5% is present which might be due to the presence of lycopene which is the potent antioxidant molecule and is effective in scavenging the reactive oxygen species hence leading to potential health benefits. The product also has a water activity of 0.46 which comes into a safe zone against microbial infestation. Sarkar *et al*. (2020) [12] reported a moisture content of 3.39% and water activity of 0.25 for *bhujia* made with incorporation of 20% spent hen meat.

Conclusion

RTE snacks formulated with tomato pomace not only helps in utilizing an industrial waste from tomato processing industries but also can be used in making enriched food products. This ingredient is available at a low cost and has great nutritional potential making it an ideal ingredient as a functional food. The snacks incorporated with TPP are not only convenient but serve the dual purpose of snacks and hence allure taste buds. Its addition also has economic benefits as it helps in effective utilization of the by-product and at the same time increases the yield of the final product by 60% as compared to the control sample having no TPP. Hence, the utilization of TPP should be promoted to achieve sustainability.

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