Original Article

International Journal of Food, Nutrition and Dietetics
Volume 11 Number 3, September – December 2023
DOI: http://dx.doi.org/10.21088/ijfnd.2322.0775.11323.3

Waste Utilization of Farm Produce for Nutritional Improvement: A Tomato Pomace Powder Biscuit

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How to cite this article:
Keshav B. Kamaliya, R. L. Rajput, Devesh H. Patel/Waste Utilization of farm Produce for Nutritional Improvement: A Tomato Pomace Powder Biscuit/Int J Food Nutr Diet. 2023;11(3):105–111.

Abstract

Large amount of farm produces, particularly vegetables and fruits, are processed. Tomato is processed mainly into puree, paste, ketchup, juice. During that a by product, known as tomato pomace (TP), is generated. Drying increase the shelf life of TP. Dried TP is carrier of numerous health beneficial bioactive substances. Consumption of bakery products is increasing. Increasing health consciousness and easy modification of bakery products has led to their development as therapeutic products. Thus proposed study was planned to utilize TP for development of biscuit and evaluate its nutritional composition and shelf life. Dried TP was powdered (TPP) and used for product optimization. For that, Maida was replaced with TPP at various levels in the commercial biscuit formula and evaluate sensorily (6 penalists x 3 times) using composite scoring test. Later on, spices were added at different levels to improve test. Ten percent TPP along with Oregano powder, Chilli flax and Garlic powder at 1% level and Black pepper powder at 0.5% scored the highest thus considered as Experimental Biscuit (EB). The biscuit could store up to two months at room temperature in plastic bag. Raw material, CB and EB were analysed for various nutrients using standard methods. The fiber content were increased by 2023% in TPP biscuit as compared to control. Thus developed biscuit could be useful for person suffering from lifestyle diseases. The mineral control was also increased by 227% that make biscuit more nutritious.

Keyword: Health food; Biscuit; Tomato pomace powder; Farm produce waste utilization.

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Received on: 19.05.2023 **Accepted on:** 30.06.2023

INTRODUCTION

Large amount of farm produces, particularly vegetables and fruits, are processed into juice, paste, powder, pieces etc. because of huge seasonal production and perishable nature. They are carrier of numerous nutritional and health beneficial bioactive substances, thus are very important components of the human diet. Tomato (*Lycopersicon esculentum*) is one of the most consumed vegetables worldwide in both form, fresh as well as processed products. Tomatoes are among the most popular vegetables

in our country. Tomato is also one of the main source of minerals, vitamins and antioxidants (like carotenoids, flavonols, vitamin C and tocopherol), potassium, vitamins D, K and from the B group as well as dietary fibre (Bożena 2017 and Deepak *et. al.* 2018).[1,2]

The food processing industry produces large quantities of waste coproducts. (Kamaliya 2021). Tomato is processed mainly in to tomato puree, paste, ketchup, juice. During that a by product, known as tomato pomace, is generated. This by product represents about 4% of the fruit weight. Tomato pomace consists of the dried and crushed skins and seeds of the fruit (Bhat *et. al.* 2017). This by product or waste is just disposed and allowed to spoil which increases landfill costs and concerns about solid waste (Deepak *et. al.* 2018).[2] Drying process (convection or freeze drying) has been shown to be the most favourable pre-treatment for the preservation of fruit and vegetable processing industry by products (Jelena 2016).[5] Dried tomato pomace, is considered as a potential food ingredient because of high dietary fibre, phenolics content, valuable oils, vitamins and secondary metabiolites. Keeping in view the above mentioned nutritional value of tomato pomace and its subsequent drying to reduce its disposal problem, it can be used in different products after its drying (Bhat *et. al.* 2017).[4]

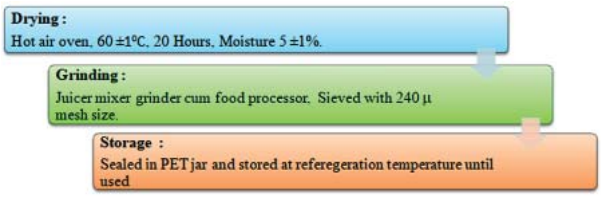
In present scenario, there is an increasing demand for conversion of fruit and vegetable wastes into useful products as well as to minimize environmental impact of these by products (Bhat and Ashan 2015).[6] Changes in the socio-economic conditions have increased the domestic demand and consumption of bakery products. Increasing health consciousness and easy modification of bakery products has led to their development as therapeutic products suitable to individual needs (Kamaliya and Rema 2016).[7] Successful incorporation of tomato pomace into bakery products that deliver physiologically active components represents a major opportunity for food processors providing the consumer a healthy wheat based product to choose from which is currently lacking in the marketplace. Keeping in view the bioactive potential and health benefits of tomato pomace, the proposed study was undertaken to investigate the utilization of tomato pomace for development of wheat based biscuit.

MATERIALS AND METHODS

Tomato pomace was dried and powdered then used for the development of biscuit. The biscuit was studied for their shelf life and nutritional composition.

Preparation of tomato pomace powder

Tomato pomace, obtained after juice extraction for ketchup preparation, as a part of experiential learning for the students for commercial purpose was collected from the Center of Fruit Processing, Department of Horticulture, B A College of Agriculture, Anand Agricultural University, Anand, Gujarat, India. For juice extraction, tomato was obtained from the local market, cleaned, cut in to pieces and juice was extracted in juicer. The pulp left was dried and converted to powder as shown in Fig. 1 and used for further analysis and product development.



Product development

Biscuit was developed in the laboratory following scientific method as detailed below.

Recipe Optimization

To develop biscuit, good quality raw materials of specific brand were purchased from the commercial market of Anand. That were cleaned, filled in airtight PET jar, stored at refrigeration temperature and used throughout the study. The perishable materials like Maida were purchased as and when required of same brand. Fresh glass distilled water was prepared in the laboratory and used to prepare the biscuit. Recipe namely sweet and salty biscuit (Patel *et. al.* 2018) were selected for modification on the bases of survey of local bakeries and successfully prepared in the laboratory conditions. Thereafter, TPP was replaced at different levels into Maida in the formula and biscuits were prepared.

Sensory Evaluation

Biscuits produced after every change were analyzed for sensory attributes and one level was selected for further experimentation. For that samples of biscuits were randomized and presented in foil covered glass dishes to trained panelists on the next day of preparation (*i.e.* day 1). Panelists were supplied with RO water for cleansing the palate between samples. Product evaluation was carried out under 'day light' illumination and in

isolated booths within the laboratory. Each sample was tasted 18 times (*i.e.* 6 panelists x 3 replications). A sensory judging panel was constituted with six panelists from among the faculties, staff and students of the School of Baking, Polytechnic in Food Science, College of Food Processing Technology as well as Dairy Science. The panelists evaluated the volume, crust colour, crumb colour, taste and aroma, mouth feel and over all acceptability of the biscuits using composite scoring test (prescribed by CFTRI, Mysore).

Primary trials

Biscuits were prepared by replacing Maida with TPP at 5, 10 and 15% level in the formula. Biscuit prepared using the commercial formula (*i.e.* 0% TPP) served as the control biscuit (CB) and was used for comparison. The biscuits produced were analysed for sensory attributes. The sensory score assigned by panelists were analysed statistically. The biscuit that scored the highest among TPP incorporated biscuit was selected for further refinement. Replacement rate of newly introduced raw ingredients were narrowed down in such a way that percent replacement of TPP of "selected product" remains some were in the middle.

Taste Improvement

Panellists commented to improve the taste. For that it was decided to add Oregano powder, Chili flakes, Garlic powder and Black pepper powder. Repeated trials of biscuit preparation was carried out with different levels of these ingredients and one level was selected on the bases of sensory evaluation. That was carried out as similar to primarytrials.

Final Selection

For that, trials of biscuit preparation were carried out by replacing TPP with Maida at 5, 7.5, 10 and 12.5% and evaluated as similar to taste improvement. The biscuit ranked the highest overall acceptability considered as the Experimental Biscuit (EB) and used for subsequent study.

Storage study

That was carried out to know the length of preservation for commercial point of view. Finally selected TPP replaced biscuit and control biscuit were packed in three types of packaging materials *i.e.* polyethylene bag, aluminum foil and plastic container and preserved at ambient and refrigerated temperature. That were analysed sensorily until found acceptable at the 15 days interval.

Nutritional Evaluation

To guesstimate the health beneficial effect of developed biscuit moisture (AOAC 1984),[9] protein (Oser 1976),[10] fat (Soxhlet), carbohydrate (by difference), fiber (kit method - Sigma Kit no. TDF 100 A-method was based on Pak *et. al.* 1989),[11] ash (AOAC 1984)[9] content of control and developed biscuits were determined.

DATA ANALYSIS

The standard SPSS program was run to analyse the data. All the data were tested for significance using the ANOVA/Duncan's test (Steel and Torrie 1980).[12]

RESULTS AND DISCUSSION

Present study was planned to utilize the farm produce processing waste. For that biscuit was developed using TPP and evaluated for their shelf life and also assessed its nutritional quality. The results obtained are discussed below.

Primary Selection

Composite scoring test was conducted for the selection of replacement level of TPP. The results of sensory evaluation obtained are depicted in Table 1. However, TPP at 10% level scored the highest among all the TPP replaced biscuits. Thus it was decided to prepare biscuits with 5, 7.5, 10 and 12.5% replacement levels with TPP for final selection.

Table 1: Sensory score of biscuit prepared by replacing Maida with different levels of TPP

Character Product	Volume	Crust characteristics	Crumb colour	Crumb texture	Taste and aroma	Mouth feel	Over all acceptability
	-10	-10	-10	-20	-30	-10	-10
				Primary trials			
Control#	7.39[a]	7.06 [a]	7.14 [a]	14.56 [a]	20.67 [a]	6.94 [a]	8.06 [a]
	± 0.32	± 0.24	± 0.38	± 0.53	± 1.00	± 0.29	± 0.21

table cont...

5% TPP	6.33^{ab}	6.06 ^{b}	6.00 ^{b}	11.56	16.83 ^{b}	4.94 ^{b}	5.33 ^{b}
	± 0.27	± 0.23	± 0.30	± 0.64	± 1.00	± 0.29	± 0.39
10 % TPP	6.72^{ab}	6.06 ^{b}	6.08 ^{b}	11.89	14.33 ^{b}	4.92 ^{b}	5.67 ^{b}
	± 0.28	± 0.26	± 0.27	± 0.49	± 0.62	± 0.31	± 0.34
15%TPP	6.56^{b}	5.94 ^{b}	5.86 ^{b}	10.89	15.67 ^{b}	5.11 ^{b}	5.25 ^{b}
	± 0.28	± 0.36	± 0.34	± 0.99	± 1.07	± 0.44	± 0.37
F Value	2.47	3.55	3.21	5.47	8.4	8.45	16.13
CV%	18.17	18.71	22.28	23.9	23.64	26.12	23.15
Addition of spices (test improvement)							
Control#	7.11 ^{a}	7.17 ^{a}	7.25 ^{a}	14.83 ^{a}	22.33 ^{a}	7.89 ^{a}	7.75 ^{a}
	± 0.35	± 0.41	± 0.34	± 0.68	± 1.04	± 0.35	± 0.26
5% TPP	7.39 ^{a}	6.50 $^{a\,b}$	6.58 $^{a\,b}$	14.11 $^{a\,b}$	15.67 $^{a\,b}$	5.03 ^{b}	5.42 $^{a\,b}$
	± 0.34	± 0.34	± 0.35	± 0.64	± 1.38	± 0.59	± 0.46
7.5% TPP	7.17 ^{a}	6.17 $^{a\,b}$	6.08 $^{a\,b}$	13.33 $^{a\,b}$	16.25 ^{b}	5.14 ^{b}	6.06 $^{a\,b}$
	± 0.35	± 0.34	± 0.38	± 0.94	± 1.70	± 0.63	± 0.46
10%TPP	7.28 ^{a}	6.78 $^{a\,b}$	6.97 $^{a\,b}$	13.44 $^{a\,b}$	18.75 ^{b}	5.42 ^{b}	6.56 $^{a\,b}$
	± 0.41	± 0.44	± 0.27	± 0.68	± 1.31	± 0.52	± 0.40
12.5% TPP	7.06 ^{a}	6.00^{b}	6.22^{b}	12.89^{b}	16.67 ^{b}	5.11 ^{b}	5.83^{b}
	± 0.40	± 0.32	± 0.38	± 0.67	± 1.77	± 0.64	± 0.53
F Value	0.13	1.58	2.02	1.08	3.45	4.84	4.34
CV%	21.89	24.25	22.2	22.59	34.63	41.26	28.92
Final selection (pooled of 3 trials)							
Control#	7.12 $^{b\pm}$	6.80 ^{c}	6.82 ^{c}	13.76^{bc}	20.06^{bc}	6.54^{c}	6.57^{d}
	0.16	± 0.16	± 0.15	± 0.26	± 0.53	± 0.17	± 0.17
5% TPP	7.20^{b}	6.89 ^{b}	6.81 ^{b}	13.94 ^{a}	20.78 ^{a}	6.91 ^{a}	6.99^{ab}
	± 0.13	± 0.10	± 0.10	± 0.26	± 0.43	± 0.14	± 0.12
7.5% TPP	7.51 ^{b}	7.44 ^{c}	7.26 ^{c}	14.81^{bc}	22.80^{bc}	7.48^{bc}	7.66^{c}
	± 0.13	± 0.11	± 0.13	± 0.25	± 0.45	± 0.16	± 0.14
10%TPP	7.98 ^{a}	7.84 ^{a}	7.71 ^{a}	15.26 ^{a}	23.00 ^{a}	7.53 ^{a}	7.58 ^{a}
	± 0.10	± 0.13	± 0.12	± 0.22	± 0.30	± 0.13	± 0.14
12.5% TPP	7.43 ^{b}	7.25 ^{b}	7.19 ^{b}	14.56 ^{b}	21.42 ^{b}	7.15^{ab}	7.20^{bc}
	± 0.14	± 0.12	± 0.13	± 0.29	± 0.48	± 0.16	± 0.15
F Value	6.5	11.72	8.58	5.76	8.2	7.55	9.52
CV%	13.08	12.57	12.96	13.1	15.13	15.39	14.81

TPP = Tomato Pomace Powder

#Control = 100% Maida (Baker's percentage)

All the replacements are based on baker's percentage

Values are Mean ±SEM scores of a composite scoring test by a panel of 6 judges X 3replications

Means bearing the same superscript within the column do not differ significantly ($p \leq 0.05$),

Values in parentheses are the number of maximum scores

Taste Improvement

Among various trials carried out with varying levels of spices panel lists preferred biscuit prepared with addition of Oregano powder, Chilli flax and Garlic powder at 1% level and Black pepper powder at 0.5%, the most. The sensory score obtained is depicted in Table 1. Along with spices 10% TPP replaced biscuits scored the highest including control. The formula standardize for biscuit preparation is given in Table 2.

Table 2: Formula for simple and finally selected TPP replaced biscuit

Product	Control Biscuit	TPP Replaced Biscuit
Ingredients	**Quantity (baker's percentage)**	
Flour	100	90
TPP	Nil	10
Shortening	40	40
Sugar (powdered)	20	20
Ammonium bicarbonate	4	4
Salt	2	2
Ajwain	1	1
Cumin seed	2	2
Oregano	0	1
Chilli flaks	0	1
garlic powder	0	1
Black paper powder	0	0.5
Milk	20	20

Final selection

For the final selection of level of TPP replacement, biscuits prepared by replacing *Maida* with narrow range incorporation of TPP were analyzed for various sensory attributes. The results obtained are presented in Table 1. The results indicated that the panelists gave more score to TPP replaced biscuits than control biscuit (containing no TPP) for all the sensory characteristics. However the highest score for all the sensory attributes was found for the biscuits with 10% TPP replacement. Therefore, it was considered as experimental biscuit and used for further experimentation.

Different researchers found the acceptable level of TPP addition from 4 to 7.5% (Basma e*t. al.* 2020, Bhat and Ashan 2015, Ahmad *et. al.* 2017, Isik and Topkaya 2016).[13,6,14] However that is less than observed in the present study. Basma *et. al.* (2020)[13] reported that, all the sensory evaluation characters; taste, colour, appearance, crispness, and overall acceptability, had significant difference between the control sample and biscuit samples which substituted with 2.5, 5, and 7.5% of TPP. The results of the present study are in agreement with that but not in agreement with Bhat and Ashan (2015), whorevealed that overall desirability sensory scores were not significantly different between control and tomato pomace powder incorporated cookies.

Storage study for TPP biscuit

TPP biscuits packed in plastic bag and plastic container found acceptable sensorily up to 2 months. However, biscuit packed in aluminum foil found acceptable up to 2½ month. Observations made are concluded in Table 3. Ahmed *et.al.* (2017)[15] reported that biscuits prepared with 2, 4 and 8% TPP incorporation and stored at room temperature found acceptable upto 45 days.

Table 3: Acceptability of control and finally selected TPP biscuit at different intervals during storage using Sensory evaluation.

Day / Week	Result
0 Day to 4th Fortnight	Found acceptable in all the packaging materials and at both the temperatures
5th Fortnight	Both biscuit packed both in Polyethylene bag and Plastic container at both the temperatures i.e. Room temperature and Refrigeration temperature found not acceptable while both types of biscuit packed in aluminum foil at both storage conditions found acceptable
6th Fortnight	Both types of biscuit (Control and TPP) packed in aluminum foil at both the temperature i.e. Room temperature and Refrigeration temperature scored less than 5 i.e. not acceptable

Nutritional Composition

Control and developed biscuit were analyzed for various nutrients in 3 replications. Results obtained are presented in Table 4.

Table 4: Nutritional composition of control and finally selected TPP replaced biscuit

Nutrient	Flour	TPP	Control Biscuit	TPP Biscuit	% Change
Moister (g%)	13.13	8.11	9.12	10	9.28
	± 0.15	0.8	0.5	0.58	0.82
Protein (g%)	11.27	5.5	5.9	5.46	-8.56
	± 0.11	0.56	0.1	0.31	0.85

table cont.....

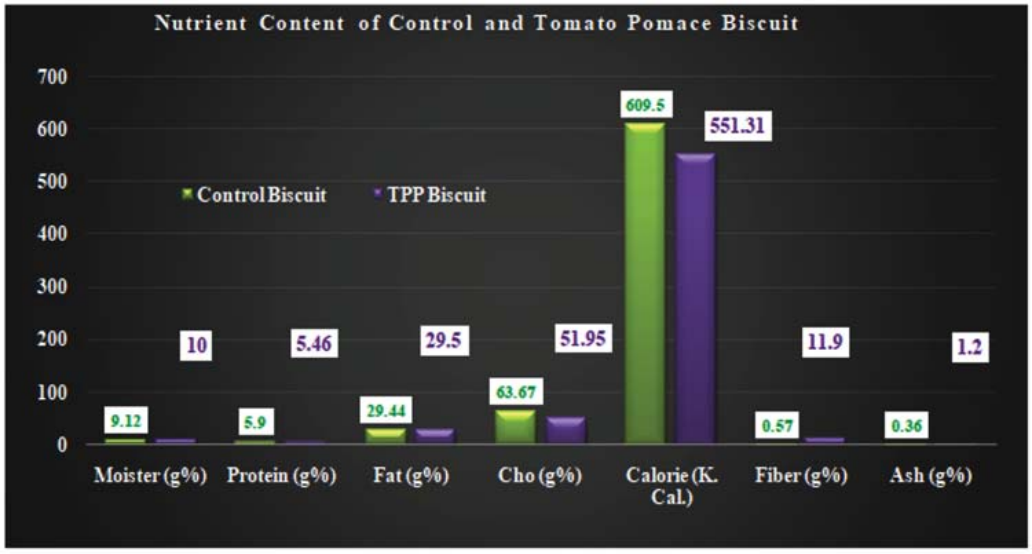
Fat (g%)	1.52	2.13	29.44	29.5	0.44
	± 0.09	0.35	0.5	1.15	0.05
Carbohydrate (g%)	85.34	24.05	63.67	51.95	-18.51
	± 1.22	0.98	3.39	3.19	0.6
Calorie (K. Cal.)	400.82	156.35	609.5	551.31	-9.55
	± 9.66	4.84	8.78	10.58	0.32
Fiber (g%)	1.06	65.15	0.57	11.9	2023.21
	0.56	2.35	0.05	0.91	22.5
Ash (g%)	0.7	3.16	0.36	1.2	227.03
	0.05	0.53	0.05	0.05	6.75

TPP = Tomato pomace powder

Values are Mean ± SEM of 3 replications

Value for carbohydrate calculated by difference

All the data except moisture is reported on dry weight bases



The fiber content was increased by 2023% percent in TPP biscuit as compared to control. Thus developed biscuit could be useful for person suffering from lifestyle diseases. The mineral content was also increased by 227% that make biscuit more nutritious.

The dietary fiber content of TPP was observed 65.15% which is slightly higher (62.04% and 59.94%) than reported by Jellena *et. al.* (2016) and Isik and Topkaya (2016), respectively. Value of ash content (3.16%) was similar (3.49%) to that of observed by Isik and Topkaya (2016). However, value for carbohydrate (24.05%) was found similar (25.39%) to Jellena *et. al.* (2016).

CONCLUSION

After repeated trials of biscuit preparations followed by sensory evaluation carried out by a panel of experts, the final formula developed and accepted was biscuit with replacement of 10% TPP into Maida and addition of Oregano powder, Chilli flax and Garlic powder at 1% and Black pepper powder at 0.5%. The developed biscuits could be stored upto 2 months at room temperature in plastic bag and 2½ months in aluminium foil. The developed biscuit contained very high amount of fiber and ash. Thus it can be replaced the commercial biscuit in chronic diseases like hyper cholesterolemic, obese & diabetic subjects after clinical trials.

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