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Physical and sensory qualities of tannia (*Xanthosoma sagittifolium*) flour based enriched cookies

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Abstract

The cookies were standardised by replacing a part of wheat flour with Tannia (Xanthosoma sagittifolium) flour and using soyabean oil and sorbitol as fat and sugar substitutes. The standardised cookies were further enriched with wheat bran (2 to 4 %) and garden cress seed and flax seed (2, 4 and 6 %) in 1:1 proportion. The sensory evaluation and physicochemical quality of cookies revealed that 20 % substitution of tannia tuber flour has overall high acceptance similar to control (100 % refined wheat flour) cookies (p>0.01). Enrichment of 2 % wheat bran and 6 % of both garden cress seeds and flax seeds (1:1) were most acceptable (p>0.01). The physical qualities were observed during forty days of storage period initially and at ten days interval. Lower diameter and spread factor, higher thickness was observed in enriched tannia flour based cookies and remained same during storage. Weight of control cookies was higher than enriched tannia cookies and gradually showed increase trend during storage. There was not much variation noticed in weight, diameter and thickness of cookies and were well compared with control. The hardness of cookies are showed decreasing trend during the storage period.

Key words: Cookies, Sorbitol, Garden cress seed, Flax seed, Wheat bran

I. INTRODUCTION

Cookies are popular snacks, widely consumed all over the world by people of all ages. Traditionally baked products are made from refined wheat flour and addition of other flours or starches can give special flavour and structural properties. The main drawback of baked products is their high trans fat content due to the use of hydrogenated fat in their preparation. There is an increased demand for healthy, natural and functional baked products and attempts are being made to improve their nutritive value and functionality by modifying the ingredients used in their preparation. Under exploited tubers can become a potential alternative in wheat based baked products, which can thus add value to the crop and at the same time enhance its economic potential.

Tannia (*Xanthosoma sagittifolium*) is an edible root crop grown in the tropics and sub tropics. It belongs to the family *Araceae*. Tannia corms are recognized as a cheaper carbohydrate source than grains or other tuber crops. Moreover, it also contains good amounts of B-complex vitamins, potassium and zinc. The flour from Tannia has been used in baking of products as it has been

reported that it has fine granule starch, which improves binding and reduces breakage of snack products. Tannia is considered as a food having low glycemic index (Folasire *et al*., 2016)[1].

Consumer demand in the field of food production has changed considerably in the last decades. Today foods are intended not only to satisfy hunger and to provide necessary nutrients for humans but also to prevent nutrition-related diseases and overall health of the consumers. In this regard, functional foods play an outstanding role. Functional foods are rapidly increasing in popularity in dairy and confectionery sectors; but in bakery industry, it is still relatively underdeveloped. Bakery products however provide ideal matrix by which functionality can be delivered to the consumer in an acceptable level. In developing functional bakery products, it is important to realize that achieving functional food quality does not simply involve delivering the active principle at the appropriate level for physiological effectiveness, but also supplying a product which meets the consumer's requirements in terms of appearance, taste and texture (Siro *et al*., 2008)[2].

In this background, an attempt has been made to improve the nutritive value and functionality of cookies by modifying the ingredients used in its preparation. The refined wheat flour in the preparation of cookies has been partially replaced with tannia flour and sugar and hydrogenated fat were fully replaced by sugar substitute, sorbitol and soyabean oil respectively. They were also enriched with functional ingredients like wheat bran (WB), flax seed (FS) and garden cress seeds (GS). The objective was to develop cookies with good taste, texture and appearance, which resembles as closely as possible to the wheat flour based product.

II. MATERIALS AND METHODS

The tuber tannia required for the study was procured from local farmer fields. The Tannia flour was prepared using the procedure given by the Aparianita *et al*. (2009)[3] with slight modification. The tubers were cleaned, peeled, washed and sliced into chips of ~5mm thickness. The chips were then blanched in boiling water for 1 to 2 minutes, cooled and soaked in a KMS solution (0.075 %) for 5 minutes. Later chips were dried in hot air oven at 50^0c for 24 hours. The dried chips were milled into flour and sifted through a 300 µm sieve. The other ingredients like sorbitol, soyabean oil, wheat bran, garden cress seeds and flax seeds were purchased from the local market

Cookies were prepared using procedure given by Easwaran (1994)[4] with slight modification. The flow chart for the preparation of cookies is given in fig.1. The different combination of tannia flour and wheat flour for the cookies preparation is shown in Table 1. Cookies prepared with 100% refined wheat flour were served as the control. The best treatment from the 5 different combinations (Table 1) was selected by sensory evaluation using score card of nine point hedonic scale for different parameters like appearance, colour, flavour, texture, taste and overall acceptability. The data on sensory qualities was statistically analysed by applying Kendall's (W) value at 1 % level of significance.

The most acceptable tannia flour based cookie (T_5) was further enriched with functional ingredients such as wheat bran at 2 and 4% and garden cress seeds and flax seeds at 2, 4 and 6% in 1:1 proportion under six treatments. The enriched cookies were also evaluated organoleptically using score card and the most acceptable combination was selected for further evaluation.

Treatments	Tannia flour(g)	Wheat flour(g)
T_0 (100% RWF)	-	-
T_1	100	-

T_2	80	20
T_3	60	40
T4	40	60
T_5	20	80

Table 1. T_0: RWF - Refined wheat flour cookies (Control), T_1-T_5 : Tannia flour cookies

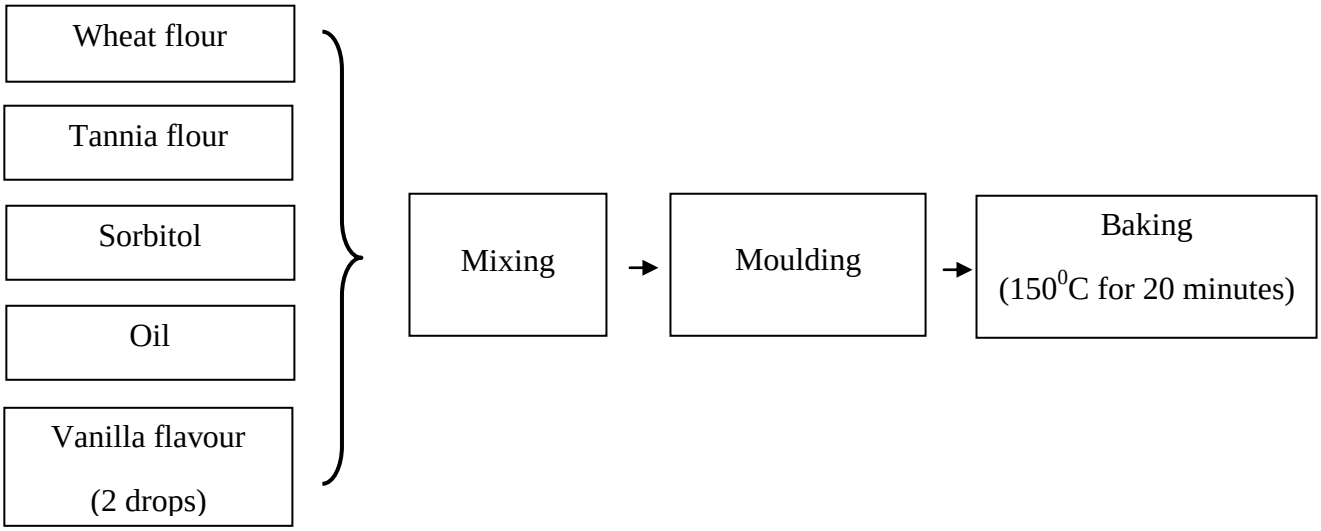


Figure 1: Flow chart for the preparation of tannia flour based cookies

The physical and sensory qualities of enriched cookie in comparison with control cookie were evaluated as follows using standard procedures. Such as diameter, weight, thickness, colour and hardness were studied for enriched cookies. Cookies weight (g) was noted using digital weighing balance and diameter (mm) and thickness (mm) was observed using verniar caliper. The mean scores with standard error were considered (Table 3). The visual observation was taken down for colour of the cookies. Hardness of the cookies were analysed using Texture Profile Analyser and mean compression values for hardness was noted. The cookies were stored for 40 days in laminated aluminium pouches in an ambient condition and observed for physical and sensory changes during storage. The sensory qualities were evaluated on initial and on 40th day of storage.

III. Results and discussion

The organoleptic evaluation of tannia flour based cookies (Table 1) showed that the tannia flour and wheat flour incorporated at the rate of 20: 80 ratio (T_5) had better mean scores for sensory attributes and was selected for enrichment purpose. With increase in the level of tuber flour in the product, the quality of the product decreased with respect to different organoleptic parameters. Up to 40 percent level of incorporation of tuber flour, the products showed acceptable quality. But maximum mean scores for different organoleptic parameters were noticed for 20 (tannia flour): 80 (wheat flour) combinations. The mean score for overall acceptability of 20: 80 combinations was better than the control cookies. A study conducted by Ojinnaka *et al*. (2009)[5] using cocoyam (tannia) in cookies preparation reported lower percentage of replacement levels than observed in the present study (only 5 % of cocoyam along with wheat flour) for obtaining acceptable cookies. Seevaratnam *et al*. (2012)[6] developed highly acceptable biscuits with incorporation of 20 percent potato flour.

Table 3. Mean scores for the organoleptic qualities of cookies prepared with Tannia flour and wheat flour in comparison with control

Cookies	Treatments	Variations (%)	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
RWF	**T_0(Control)**	100:0	7.95 (4.90)	7.80 (4.60)	7.62 (5.30)	7.66 (5.53)	7.75 (5.27)	7.68 (5.23)
	T_1	100	5.17 (1.53)	5.02 (1.50)	4.40 (1.20)	4.40 (1.33)	3.57 (1.33)	4.20 (1.47)
	T_2	80:20	6.02 (1.93)	5.77 (2.00)	5.44 (2.07)	5.37 (2.07)	4.35 (2.17)	5.04 (2.03)
Tannia: wheat	**T_3**	60:40	7.84 (3.20)	6.57 (3.30)	6.24 (3.27)	5.93 (3.07)	6.77 (3.00)	5.95 (2.73)
	T_4	40:60	7.66 (4.67)	7.60 (4.80)	6.84 (3.97)	6.77 (4.03)	6.60 (4.03)	6.95 (4.17)
	T_5	20:80	7.62 (4.73)	7.66 (4.80)	7.44 (5.20)	7.22 (4.97)	7.44 (5.20)	7.73 (5.37)
	Kendalls' (W) value		**0.674****	**0.648****	**0.805****	**0.782****	**0.760****	**0.822****

*Entries in the Table- 2 indicate mean scores and mean rank. ** Significant at 1per cent level*

T*- Tannia* ***W****- Wheat,* ***T_1****: 100%,* ***T_2****: 80% T+ 20% W,* ***T_3****: 60% T+40%W,* ***T_4****: 40%T+ 60%W,* ***T_5****: 20%T+ 80%W*

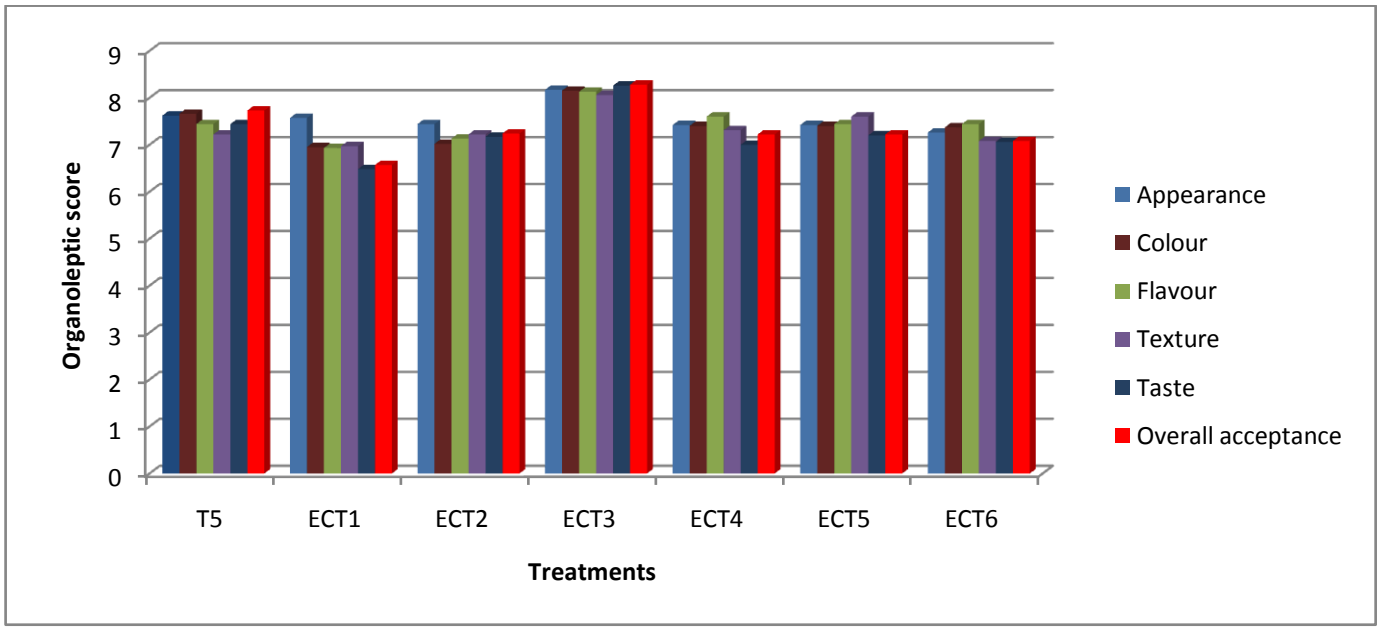


Figure 2: Mean score of sensory evaluation of Tannia enriched cookies

T_5*: 20% tannia+80% wheat* ***ECT_1****: 20% tannia+ 80% wheat +2%WB+2%FS:GS* ***ECT_2****: 20% tannia+ 80% wheat +2%WB+4%FS:GS* ***ECT_3****: 20% tannia+ 80% wheat +2%WB+6%FS:GS* ***ECT_4****: 20% tannia+ 80% wheat +4%WB+2%FS:GS* ***ECT_5****: 20% tannia+ 80% wheat +4%WB+4%FS:GS* ***ECT_6****: 20% tannia+ 80% wheat +4%WB+6%FS:GS*

Among six treatments tried for enriched cookies (Fig 2), the highest mean score for different quality attributes was noticed in cookies enriched with 2% WB and 6 % GS:FS in 1:1 proportions (ECT_3). The mean score for appearance and colour of 2:6 proportion enriched cookies (ECT_3) was 8.17 (5.77) and 8.15 (6.27) respectively. For flavour and texture the mean scores was found to be 8.13 (5.97) and 8.06 (6.17) respectively. The mean score for taste was 8.26 (6.57). The overall acceptance was found to be lower for control (20 Tannia: 80 WF, 7.73 (4.97)) han 2:6 proportion of enriched cookies (8.28 (6.53). The most acceptable enriche tannia cookie was further studied for

physical and sensory attributes in comparison with RWF (T_0- Table 1). Patil *et al.* (2015) incorporated garden cress seed powder in the biscuits at 5, 10, 15 and 20 percent levels and maximum acceptance in terms of organoleptic qualities was noticed for biscuits prepared at 10 percent level. Alpers and Sawyer Morse (1996)[8] conducted study on ground flaxseed substitution in banana nut muffins and cookies and found that replacement of ground flax at level of 30 % and 33 % were having good overall acceptance. According to Hussain *et al*. (2006),[9] the wheat based cookies in combination with 20% whole flax seeds showed good sensory characters with high acceptance. Pasha *et al*. (2008)[10] suggested that substitution of wheat bran, corn bran about 20 % each and psyllium 10% in cookies preparation found highly acceptable and stated that increase in bran content will decrease the calorie value.

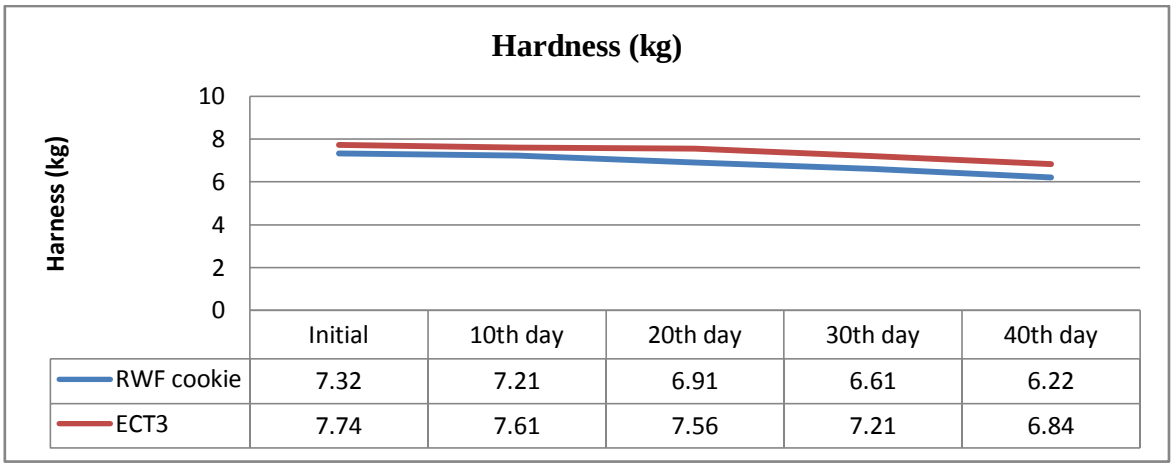
Table 3. Physical qualities of enriched Tannia cookies (ECT_3*) in comparison with RWF cookies (Control)*

Parameters	Days of storage									
	Initial		10^{th} day		20^{th} day		30^{th} day		40^{th} day	
	RWF	ECT_3	RWF	ECT_3	RWF	ECT_3	RWF	ECT_3	RWF	ECT_3
Diameter (mm)	46.6± 0.023	45.6± 0.16	46.6± 0.023	45.6± 0.16	46.6± 0.023	45.6± 0.16	46.6± 0.023	45.6± 0.16	46.6± 0.023	45.6± 0.16
Weight (g)	18.16± 0.003	16.99± 1.23	18.24± 0.002	17.08± 1.24	18.29± 0.001	17.12± 1.25	18.35± 0.002	17.17± 1.25	18.41± 0.003	17.22± 1.26
Thickness (mm)	1.12± 0.016	1.32± 0.025	1.12± 0.016	1.32± 0.025	1.12± 0.016	1.32± 0.025	1.12± 0.016	1.32± 0.025	1.12± 0.016	1.32± 0.025
Spread factor	4.16± 0.016	3.45± 0.024	4.16± 0.016	3.45± 0.021	4.16± 0.018	3.45± 0.022	4.16± 0.013	3.45± 0.016	4.16± 0.016	3.45± 0.022

RWF: refined wheat flour ECT_3: enriched cookie 2% WB : 6% GS+FS

The entries (Table 3) points out the physical qualities of selected enriched tannia (ECT_3) cookies during 40 days of storage period. The diameter of ECT_3 was lower than the control. Initially the diameter for ECT_3 and T_0 were 45.6mm and 46.6mm respectively and remained same till 40 days of storage. Enriched tannia flour based cookies had lower weight than control and increased gradually and on 40^{th} day of storage the weight was 18.41mm for control and 17.22mm for enriched cookies (ECT_3) and its may be due to moisture absorption. Thickness of enriched tannia based cookies was higher than the control and remained the same throughout the storage period. Initially the spread factor of enriched tannia cookies was 3.45 which were found to be lower than control (T_0). The spread factor remained same throughout the storage for all the products. Enriched cookies had dark golden colour after baking. In case of control (T_0) the colour was light creamy golden brown. The maximum hardness was noticed in ECT_3 *i.e.* 7.74kg than control (7.32kg). The hardness of the cookies reduced during 40 days of storage and the values were 6.22kg for control cookies 6.84kg for ECT_3. Igbabul *et al*. (2015)[11] studied the physical properties of cookies prepared with wheat, cocoyam and African yam beans, he revealed that physical properties varied with substitution of composite flours than wheat flour alone, weight (18.01-20.15g), diameter (6.48-6.82cm), thickness (0.45-0.55cm). Gonarkar and Jain (2014)[12] reported that hardness of cookies decreased with increase in flaxseed content and opined that physical parameters were increased with increase in flax seed. Lower thickness was observed in control cookies *i.e.* 50 ± 0.76 mm and diameter of 286.75 ± 0.96mm while at 30 % RFF (Roasted flax flour) the highest thickness of 69.33 ± 1.15 mm and diameter of 321.25 ± 0.96mm were observed in cookies. Colour of the cookies varied from medium brown to dark brown. Chinma and Gernah (2007)[13] reported lower spread ratio for cookies

prepared using composite flour. Arshad *et al*. (2007)[14] observed decrease in spread ratio from 7.19 to 5.69 in cookies prepared with incorporation of defatted wheat germ and also noticed change in colour of cookies from light brown to darkish black tint with incorporation of defatted wheat germ. Singh *et al*. (2008)[15] observed that hardness of cookies decreased with increased proportion of sweet potato flour and noticed optimum hardness in cookies prepared with 20 per cent sweet potato flour in combination with wheat flour. Addition of functional ingredients in basic recipe could make positive effects on the physical properties of cookies.



	Initial	10th day	20th day	30th day	40th day
RWF cookie	7.32	7.21	6.91	6.61	6.22
ECT3	7.74	7.61	7.56	7.21	6.84

Figure 3: Effect of storage on hardness of Tannia enriched cookies in comparison with RWF cookies

RWF: Refined wheat flour ECT_3: 20% tannia+80% wheat+ 2%WB+ 6% FS-GS

The mean scores for different organoleptic qualities of enriched tannia cookies in comparison with control are presented in Table-4.

The mean scores for appearance of enriched tannia cookies were higher than control during storage period. Initially, the mean score for appearance was 7.95 (5.97) and 8.17 (5.77) for enriched tannia cookies. On 40^{th} day of storage, the mean scores for appearance was 8.22 (4.25) for control and 8.21 (5.25) for enriched tannia cookies. Mean score of colour for enriched tannia cookies was higher than control and slight increase in mean score was noticed in cookies on 40^{th} day of storage, initially mean score for colour was 7.80 (5.10) for T_0 and 8.15 (6.27) for ECT_3 which was increased to 7.81 (5.20) and 8.16 (6.01) respectively.

For flavour and texture maximum mean scores was noticed in enriched tannia cookies than control. The mean score for flavour and texture of T_0 was 7.62 (4.80) and 7.66 (5.10) and for ECT_3 8.13 (5.97) and 8.06 (6.17) respectively. Variations in mean score for flavour and texture was noticed in evaluations carried out on 40^{th} day of storage. But an increase in mean score from the initial value was noticed for texture and flavour. The maximum mean score for taste was noticed in enriched tannia based cookies than control and increase in mean score was noticed on 40^{th} day of storage *i.e*. a gradual increase in mean score from an initial value of 7.75 (5.00) to 8.60 (2.25) for T_0 and from 8.26 (6.57) to 8.44 (2.31) for enriched tannia cookies

Initially, the mean score for overall acceptability was 7.68 (4.87) for T_0 and 7.62 (5.73) for $ECTT_{21}$. The mean score for overall acceptability on 40^{th} day of storage was 8.99 (3.11) for CT_0, 8.47 (3.11) for $ECYT_{15}$ and 8.81 (3.38) for $ECTT_{21}$.

Table:4 Mean scores for the organoleptic qualities of enriched tuber based cookies during storage period

Treatments	Appearance		Colour		Flavour		Texture		Taste		Overall acceptability	
	1 day	40th day	1 day	40th day	1 day	40th day	1 day	40th day	1 day	40th day	1 day	40th day
Control(RWF)	7.95 (5.97)	8.22 (4.25)	7.80 (5.10)	7.81 (5.20)	7.62 (4.80)	7.62 (4.05)	7.66 (5.10)	7.64 (3.08)	7.75 (5.00)	8.60 (2.25)	7.68 (4.87)	8.99 (3.11)
ECT_3	8.17 (5.77)	8.21 (5.25)	8.15 (6.27)	8.16 (6.01)	8.13 (5.97)	8.11 (3.08)	8.06 (6.17)	8.15 (3.18)	8.26 (6.57)	8.44 (2.31)	7.62 (5.73)	8.81 (3.38)

RWF: Refined wheat flour ECT_3: 20% tannia+80% wheat+ 2%WB+ 6% FS-GS

IV. Conclusion

The research finding depicted that underexploited tubers can be used effectively in the preparation of cookies along with functional ingredients. Around 20 % of replacement of tannia flour along with 2% addition of wheat bran and 6 % of both flax seed and garden seed in 1:1 had higher organoleptic scores. The result showed that physical qualities like hardness decreased across the storage period but wide variation was not noticed in diameter and thickness, weight of the cookies slightly increased due to moisture absorption during storage. The tuber flour tannia and functional ingredients used in the study can be utilized effectively to substitute wheat flour in the preparation of cookies. The sensory qualities increased during storage period. Use of refined soyabean oil and sorbitol was found to be compatible for cookie preparation.

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