



RESEARCH ARTICLE

Evaluation of the Nutritional Characteristics for Tamarind kernel Flour Incorporated Cookies

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ABSTRACT

Tamarind kernels are typically under-emphasized by products of the tamarind pulp industry. The kernel is a fair source of protein, fat (essential fatty acids), carbohydrates and minerals, which can replace conventional flour to develop new food products. The study aims to exploit the under-utilized tamarind kernel for value addition to improve tamarind kernel-based food products' acceptability and consumption. The tamarind kernel incorporated cookies at 50 percent level of incorporation had moisture of 1.62 %, carbohydrate content of 72.52%, protein of 9.26 %, fat of 22.98%, fiber of 3.25% and ash of 1.12%, respectively. The developed cookies had higher protein and fiber content than control cookies, which depicts its potential to be the better alternative for the conventional flour.

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INTRODUCTION

Tamarind, an evergreen, leguminous and multipurpose tree, belongs to the family of Fabaceae. Every year, 2 lakh tonnes of tamarind seeds are wasted in India (Project report by NIIR, 2020). The major area of production is from Asian countries, mainly Thailand, India, Bangladesh and Srilanka. India is the world's largest producer and consumer of tamarind (Shankaracharya., 1998).

Tamarind kernel is nutritionally abundant which contains higher levels of protein content particularly high levels of essential amino acids. Apart from legumes, tamarind seeds can be used to address protein-energy malnutrition. The tamarind kernel is a rich source of carbohydrate content. The polysaccharide isolated from the tamarind kernel possesses excellent thickening properties. The tamarind kernel is also a rich source of minerals like calcium, phosphorus and magnesium. The phytochemical profile of the tamarind kernel exhibits its potential sources of antioxidant (Siddhuraju., 2007), anti-diabetic, anti-stress (Razali *et al.*, 2015) and anti-hyperlipidemic components (Maiti *et al.*, 2005).

There is an increased demand for value addition from waste products of food processing industries (Balasundram *et al.*, 2006). Tamarind kernel possesses nutritional, nutraceutical and medicinal value, which serves as an important

source for value addition in food products. The study aims to value add the tamarind kernel by pulverizing it into tamarind kernel flour and replacing the conventional flour with tamarind kernel flour.

MATERIAL AND METHODS

Raw material collection

The tamarind kernels were purchased from a local market in Madurai, Tamil Nadu, India, together with a hull measuring 12.22 mm in length and 10.86 mm in width.

Sample preparation

The tamarind kernels were sand roasted at 220°C for 10-15 seconds to ease the dehulling process. The dry heat method creates a temperature difference between the outer hull and kernel, thereby enhancing the efficiency of the dehulling process. After sand roasting, the kernels were cooled down to room temperature, hand-pounded and followed by winnowing to separate the kernel coat. The dehulled kernels were pulverized in a flourmill to obtain the kernel powder. Tamarind kernel powder was sieved using No. 80 mesh size for getting the resultant product with uniform-sized powder. The powder was stored in an air-tight glass container for further use (Sultana *et al.*, 2020).

Formulation and preparation of cookies

The composite blends of refined wheat flour and tamarind kernel flour was used to obtain control and

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tamarind kernel incorporated cookies, respectively. For control cookies, T_0 , 100% refined wheat flour was used and for treatment cookies, T_1 , 50 % incorporation of tamarind seed flour with 50% of refined wheat flour was done. The composition of cookies was flour blend- 100 g, sugar (powdered)-30 g, fat – 50 g, baking powder- 1.67 g, salt- 0.5 g and water-20 mL.

Nutritional analysis of cookies

The proximate analysis, namely moisture, carbohydrate, crude protein, crude fat, crude fiber and ash, were analyzed as per the method of the Association of Official Analytical Chemists(AOAC,2000). The changes in the above parameters of developed cookies were analyzed in the initial and end of 45 days of storage at room condition by using different packaging materials such as High-density polypropylene packages (P_1) and stand-up pouches (made up of polypropylene) (P_2). The pictorial representation of control and tamarind kernel flour incorporated cookies packed indifferent packaging materials (Figure 4).

STATISTICAL ANALYSIS

The factorial completely randomized design was adopted for analysis to study the impact of packaging materials using AGRES software, treatments and storage period on the quality of cookies.

RESULTS AND DISCUSSION

Cookies analysis

Moisture

The percentage of the moisture content for developed cookies is given in Table 1. The initial moisture content of control and tamarind kernel incorporated cookies was 2.45 and 1.62%, respectively. The final moisture content was 3.08% and 1.79%, respectively, in high-density polypropylene packages and 2.60 and 2.02 %, respectively in stand-up pouches. The highest moisture was recorded in developed cookies packed in high density polypropylene packages at the end of the storage days. Statistically, the storage period, treatments and packaging material had an impact on the moisture content of the cookies.

Table 1. Changes in moisture, carbohydrate and protein content of control and tamarind seed flour incorporated cookies

Storage period	Moisture				Carbohydrate				Protein			
	P_1		P_2		P_1		P_2		P_1		P_2	
	T_0	T_1	T_0	T_1	T_0	T_1	T_0	T_1	T_0	T_1	T_0	T_1
0 day	2.45	1.62	2.45	1.62	66.23	72.52	66.23	72.52	4.66	9.26	4.65	9.26
15days	2.50	1.64	2.49	1.63	66.22	72.51	66.23	72.52	4.64	9.23	4.64	9.24
30days	2.59	1.70	2.54	1.68	65.98	71.99	66.02	72.14	4.63	9.21	4.62	9.21
45days	3.08	1.79	2.60	2.02	64.02	70.85	65.45	71.59	4.59	9.18	4.60	9.19

Source	SED	CD(0.05)	Source	SED	CD(0.05)	Source	SED	CD(0.05)
P	0.15750	0.31001	P	0.01532	0.03100	P	0.04598	0.09165
T	0.15750	0.31001	T	0.01532	0.03100	T	0.04598	0.09165
S	0.18006	0.35897	S	0.01789	0.03489	S	0.05932	0.10598
PT	0.28976	0.54798	PT	0.02654	0.05281	PT	0.08019	0.10591
TS	0.31300	0.65879	TS	0.03125	0.06119	TS	0.09254	0.18525
PS	0.31300	0.65879	PS	0.03125	0.06119	PS	0.09254	0.18525
PTS	0.54321	1.06897	PTS	0.05296	0.10689	PTS	0.17021	0.31892

P-Packaging materials, T-Treatments and S-Storage period

T_0 - 100% Refined wheat flour T_1 - 50% Refined wheat flour +50% Tamarind seed flour

P_1 - High density polypropylene packages P_2 - Stand-up pouches

The biscuits made with 100% wheat flour had a moisture content of 5.53 + 0.5g/100g and biscuits made with 15 % incorporation of tamarind seed flour had a moisture content of 7.82+ 0.5g/100g [El-Gindy *et al.* (2015)]. Akbar (2018) recorded that the initial moisture content of control cookies (100% Wheat flour) made) was 3.20% and the final moisture content of cookies [after 90 days of storage] was 3.28%. The initial moisture content of treated cookies made (50% Wheat flour + 50 % Maize flour) was 3.23% and the final moisture

content of cookies [after 90 days of storage] from wheat flour and maize flour (T_1) was 3.31%. The increase in moisture content was attributed to the hygroscopic nature of the cookies packed in packaging materials, the nature and porosity of the packaging material [Goyat *et al.*, 2018].

Carbohydrate

The percentage of the carbohydrate content of cookies is given in Table 1. The carbohydrate content of control (T_0) and tamarind kernel incorporated

cookies (T_1) was 66.23% and 72.52%, respectively, in both the packaging materials. The final carbohydrate content of control and tamarind kernel flour incorporated cookies was 64.02 g and 70.85 g in high-density polypropylene packages and 65.45 g and 71.59 g in stand-up pouches. There was a decreasing trend in carbohydrate content in both the control and tamarind kernel flour incorporated cookies in both the packaging materials at the end

of storage days. The loss of carbohydrate content of tamarind kernel flour incorporated cookies in high-density polypropylene packages was 2.30% and 1.28% in stand-up pouches. Statistically, the storage period, treatments and packaging material had an impact on the carbohydrate content of the developed cookies and was significant at a 0.05% level of significance.

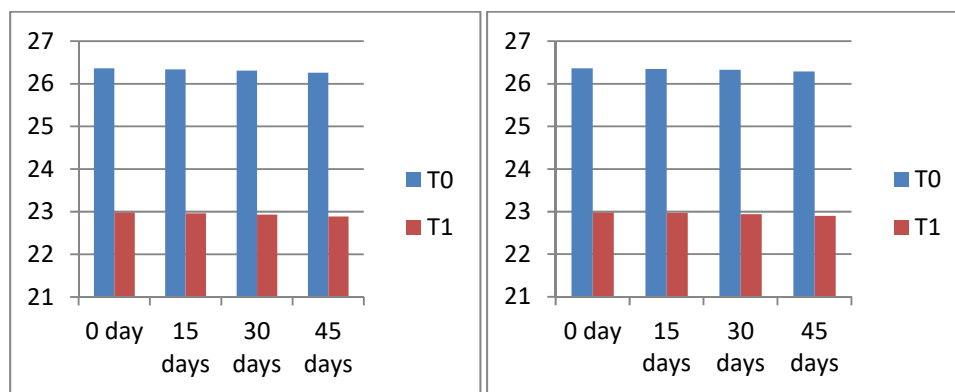


Figure 1. Changes in fat content of control and tamarind seed flour incorporated cookies packed in high-density polypropylene packages and stand-up pouches

T_0 - 100% Refined wheat flour T_1 - 50% Refined wheat flour +50% Tamarind seed flour

Indumathi *et al.* (2018) reported a decreasing trend in the carbohydrate content of the control and multigrain cookies (50% level of incorporation),

with the initial carbohydrate content of the treated cookies as 56.47 g and final carbohydrate content be 55.13 g at the end of storage of 90 days.

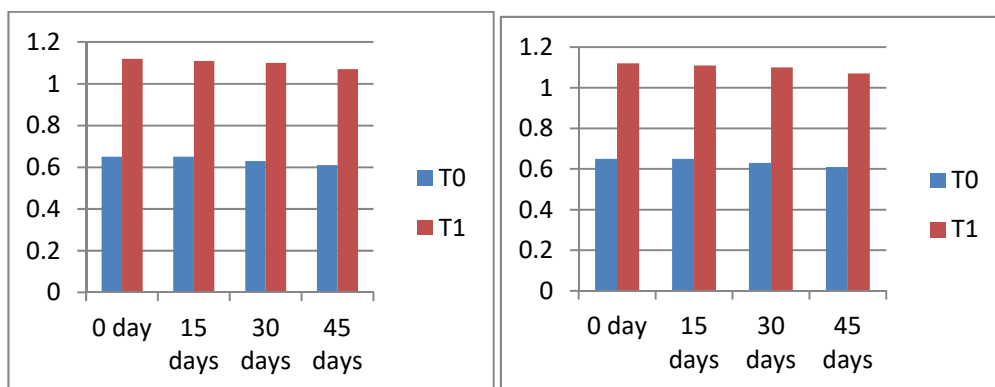


Figure 2. Changes in fiber content of control and tamarind seed flour incorporated cookies packed in high-density polypropylene packages and stand-up pouches

T_0 - 100% Refined wheat flour T_1 - 50% Refined wheat flour +50% Tamarind seed flour

Crude protein

The percentage of the protein content of developed cookies is given in Table 1. The protein content of the control cookies and tamarind kernel flour incorporated cookies was 4.64 g and 9.23 g, respectively initially and at the end of 45 days of the storage period, the protein content was 4.59 g and 9.18 g, in high-density polypropylene packages and 4.60 g and 9.19 g, in stand-up pouches. There was a decreasing trend in the protein content of both

control and tamarind kernel incorporated cookies. Stand-up pouches proved to be better in terms of retention of the protein content of the cookies when compared to the high density polypropylene packages as the loss of developed cookies was 0.86 % in high-density polypropylene packages and 0.75 % in stand-up pouches. Statistically, the storage period, treatments and packaging material had an impact on the protein content of the cookies and was significant at a 0.05% level of significance.

Akbar *et al.* (2018) reported a decreasing trend in the protein content during the storage of cookies, with the initial protein content of the treated cookies

(50% incorporation of maize flour) to be 7.92 g and the final protein content (at the end of 90 days of storage) to be 7.59 g.

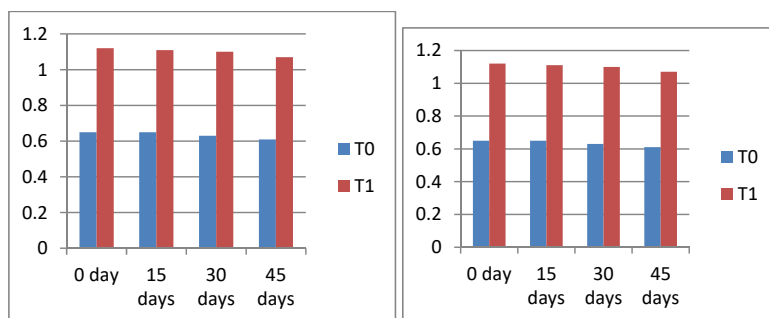


Figure 3. Changes in ash content of control and Tamarind seed flour incorporated cookies packed in high-density polypropylene packages and stand-up pouches

T₀- 100% Refined wheat flour T₁- 50% Refined wheat flour +50% Tamarind seed flour

Crude fat

The percentage of the fat content of developed cookies is given in Table 2. The initial fat content of control and tamarind kernel incorporated cookies was 26.36 g and 22.98 g, respectively. The final fat content was 26.26 g and 22.98 g, respectively, in high density polypropylene packages and 26.29 g and 22.90 g, respectively in stand-up pouches.

The fat content of the control biscuits and tamarind seed flour incorporated cookies(15% level of incorporation) were 20.25±0.2 g and 20.41±1.4 g, respectively [El-Gindy *et al.* (2015)]. There was a decreasing trend in the fat content of cookies in both the packaging materials, but the highest loss was recorded in high density polypropylene packages (P₁).



Figure 4. Control and tamarind kernel cookies in Stand-up pouches and high-density polypropylene packages

Statistically, the storage period, treatments and packaging material had an impact on the fat content of the developed cookies and was significant at a 0.05% level of significance. The data analyzed showed similarity to the work carried out by Waheed *et al.* (2010), which reported the fat content of cookies made with inter-esterified fat was 22.87% initially and 21.69% after 45 days of storage and there was a decreasing trend in fat content observed during the storage of cookies.

Crude fiber

The percentage of the fiber content of developed cookies is given in Table 2. The initial fiber content of control and tamarind kernel incorporated cookies was 0.95% and 3.25%, respectively, in

both high-density polypropylene packages and stand-up pouches. The final fiber content of control and tamarind kernel incorporated cookies was 0.89% and 3.19%, respectively, in high-density polypropylene packages and 0.90% and 3.19% respectively in stand-up pouches. Statistically, the storage period, treatments and packaging material had an impact on the fiber content of the cookies and was significant at a 0.05% level of significance.

Ash

The percentage of the ash content of cookies was given in Table 2. The initial ash content of control and tamarind kernel incorporated cookies was 0.65% and 1.12%, respectively, in both high-density polypropylene packages (P₁) and stand-up

pouches (P₂). The final ash content of control (T₀) and Tamarind kernel incorporated cookies (T₁) was 0.58% and 1.08% respectively in high density polypropylene packages and 0.61% and 1.7% respectively in stand-up pouches (P₂).

Akbar *et al.* (2018) stated the initial ash content of control cookies made from 50% incorporation of maize flour was 0.80 g and 0.75g, respectively and the ash content at the end of 90 days of storage was 0.79 g and 0.74 g. The author reported the decrease in ash content of developed cookies during storage.

CONCLUSION

The value addition of tamarind kernel in the form of cookies yielded the best results in terms of nutrient density. The protein content and fiber content of the tamarind kernel flour incorporated cookies was 9.26 g and 3.25 g, which was substantially higher than the control cookies. It can potentially address protein-calorie malnutrition and prevent life-style disorders. The storage studies revealed that there is minimal loss in stand-up pouches when compared to high density polypropylene packages. The value-added products from Tamarind kernel flour could gain good recognition in the food industries. Thus, the value addition of underutilized tamarind kernel would reap benefits to both the grower in terms of increased income and consumer in terms of increased nutritional value.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There was no conflict of interest in the publication of this content.

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