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Physicochemical Properties of Cookies Developed from Maida Substituted with Cashew Apple Powder

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Cashew apple (*Anacardium occidentale* L.) is one of India's most important tropical crops. It is a rich source of vitamin C, antioxidants, minerals, dietary fibers and carbohydrates. The study of the development of cookies based on cashew apple powder (CAP) was undertaken to use wasted cashew apples and tap the nutritional value of cashew apples. Due to astringency and the tannin content of cashew apple, people do not like it for direct consumption. The cookies were prepared by substituting 5%, 10%, 15%, and 20% maida by CAP. These four different compositions were baked

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at temperature levels 160℃, 170℃, and 180℃. The prepared cookies were evaluated for their proximate composition, including moisture content, crude ash, crude fat, crude fiber, crude proteins and carbohydrates. The sensory evaluation, colour analysis and textural analysis were done as well and energy content was determined. The results revealed that cookies substituted with 5% CAP and baked at a temperature 180°C (S_1T_3) got the highest score in sensory evaluation (7.46), browning index (50.62) and hardness (10.18 N). It was concluded that if an amount of maida were replaced by CAP, people would like to consume it more than the other flour cookies.

Keywords: Anacardium occidentale; CAP; cashew apple; cookies; sensory evaluation.

1. INTRODUCTION

The cashew tree (*Anarcardium Occidentale* L.) is an evergreen tropical tree. The cashew has been introduced by Portuguese and is a valuable cash crop in India. It belongs to the family *Anacardiaceae*. The cashew fruit has two distinct parts: the swollen and pear-shaped stalk (cashew apple) and a kidney-shaped nut attached to the apple. The apples (pseudo fruit) in general are yellow or red in colour (Bhavana & Patil, 2021).

The total cashew apple production in India was approximately 56 lakh MT in the year 2021 (Kannan et al., 2021). Maharashtra accounts for one-third of the country's total cashew production of which a significant proportion (60%) is produced in the Ratnagiri and Sindhudurg districts (Anonymous, 2021). Cashew apple contains 90% whole fruit weight. The pulp of the cashew apple is very juicy with 85-90% water, 7-13% carbohydrate, 0.7-0.9% protein, 0.2% mineral, 0.1% lipid, vitamin C at high content (261.5 mg per edible part), five or six-fold compared to orange, eight-fold compared to mandarin orange, other vitamins B1, B2, etc., and minerals Ca, P, Fe, etc. (Tran et al., 2014).

Breads and biscuits are a major part of the bakery industry and cover around 80% of total bakery products in India. This belongs to the unorganized sector of the bakery industry and covers over 70% of the total population. In India, biscuits industry came into limelight and started gaining a sound status in bakery industry in later part of the 20th century when urbanized society called for readymade food products at a tenable cost. Biscuits were assumed as sick man's diet in earlier days. Now, it has become one of the most loved fast food products for every age group. Biscuits are easy to carry, easy to eat, cholesterol free and at reasonable cost. Maharashtra has the largest intake of biscuits. The rural sector consumes around 55% of the biscuits in the bakery products. Biscuit contributes to over 13% of the total production of bakery and above 80% of the biscuits are manufactured by the small-scale sector of the bakery industry comprising both factory and non-factory units (Anonymous, 2022).

The cashew apple has been used to develop cookies. It was found to be a nutritive diet because it contains vitamin C (Tran et al., 2014). Also, good for digestion because it has higher dietary fiber as reported by Jose & Correia, (2008). Cashew apples have been utilized instead of wasted. It adds to the income of the cashew-producing farmer. Even though the cashew apple production is higher in India about 90% of cashew apples are wasted because no well-developed technology for using cashew apples is available. Also, people do not consume cashew apples directly because of their higher astringency and tannin content (Suganya & Dharshini, 2011). So, some processing technology needs to be developed. Therefore, it is necessary to develop cashew apple products that will use cashew apples as a nutritive diet and on the other hand will add to the farmer's income. Therefore, the study was conducted to develop cashew apple cookies (Offia et al., 2015).

2. MATERIALS AND METHODS

2.1 Material

The cashew apples were procured from the cashew field of CAET, Dapoli. Those were dried 50-55℃ for 27 h while other materials like maida, sugar, dalda, milk powder, baking powder, salt and essence were procured from the Dapoli local market.

2.2 Preparation of Cashew Apple Powder

The fresh cashew apples were washed thoroughly and sliced into 1cm×1cm pieces. The slices were spread uniformly over the tray as a thin layer and dried using a tray dryer at 50-55℃,

till the final moisture content of 6.5-7% (wb.) was obtained. After drying, the residue was kept to cool and ground in a hammer mill. Afterward, the material was sieved to obtain a powder with a particle size of 50 µm. The sieved powder was stored in a sealed plastic container at room temperature before use.

2.3 Details of the Experiment

The cookies were made by using four levels of the cashew apple powder 5%, 10%, 15% and 20% which were coded as S_1, S_2, S_3 and S_4 respectively. The prepared samples were baked at temperature levels of 160℃, 170℃ and 180℃ which are denoted by T_1, T_2 and T_3 respectively.

2.4 Preparation of CAP-based Cookies

The cookies were prepared by mixing ingredients as per the formula given in Table 1. The dough prepared was kept for resting for 15 minutes. The sheet of appropriate thickness was prepared with the help of a wooden roller. The cookies were cut round in shape transferred to the tray and baked at test temperature. The developed cookies were kept for cooling at room temperature for 1 h and then packed in an airtight container for further analysis.

2.5 Proximate Composition

Cookies were analyzed for moisture, protein, fat, ash, fiber and nitrogen-free extract by the methods of AOAC (2003) in NAIP lab, Department of Process and Food Engineering, CAET, DBSKKV, Dapoli.

2.5.1 Moisture content

Moisture was determined by the oven drying method. Approximately 10 g of well-mixed sample was accurately weighed into a clean, dried moisture can (W_1). Then it was allowed in an oven at 100-105℃ for 6-12 h until a constant weight was obtained. Then the crucible was

Table 1. Ingredients composition of cookies

Ingredients	S_1	S_2	S_3	S_4
Maida (g)	950	900	850	800
CAP (g)	50	100	150	200
Dalda (g)	500	500	500	500
Sugar (g)	500	500	500	500
Milk powder (g)	25	25	25	25
Salt (g)	5	5	5	5
Essence (ml)	15	15	15	15
Baking powder (g)	10	10	10	10

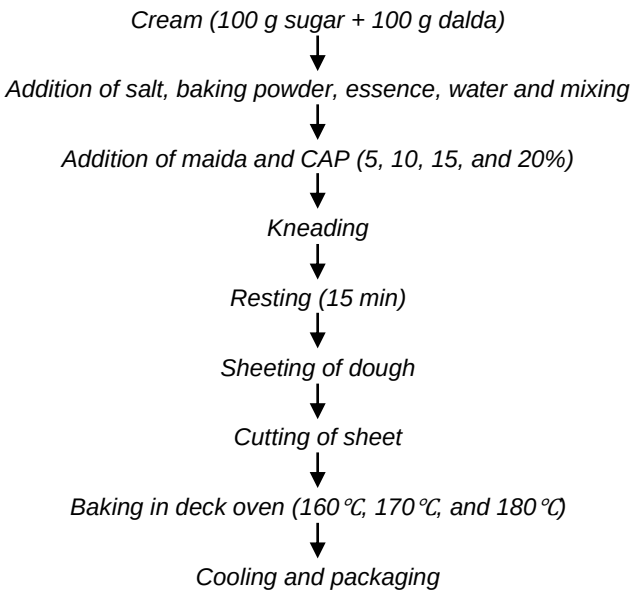

Fig. 1. Process flow chart for CAP-based cookies

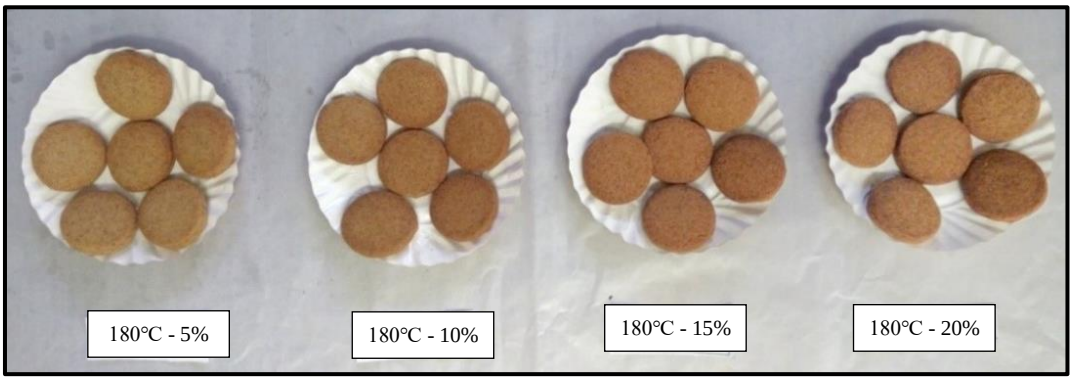

Fig. 2. Developed CAP based cookies

placed in the desiccator for 30 min to cool. After cooling it was weighed again (W_2). The following formula calculated the percent moisture content:

$$\text{Moisture}\ (\%) = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \text{ x } 100$$

2.5.2 Ash content

For the determination of ash, a clean empty crucible was placed in a muffle furnace at 600℃ for an hour, cooled in a desiccator and then the weight of the empty crucible was noted (W_1). 5 grams of each of sample was taken in a crucible (W_2). Then the crucible was placed in a muffle furnace at 600℃ for 4-6 h. After the ashing furnace was switched off. The crucible was cooled and weighed (W_3). The following formula calculated the percent ash content:

$$\text{Ash}\ (\%) = \frac{W_3 - W_1}{W_2} \text{ x } 100$$

Where,

W_1 = Weight of empty crucible (g)
W_2 = Weight of sample (g)
W_3 = Weight of sample (g)

2.5.3 Crude protein

The protein in the sample was determined by using the Kjeldahl equipment (KELPLUS DISTYL EMVA, India). Percent crude protein content of the sample was calculated by using the following formula:

$$\text{Crude Protein}\ (\%) = 6.25 \text{ x } \%\ \text{Nitrogen}$$

2.5.4 Crude fat

Crude fat was determined by the ether extract method using the Soxhlet apparatus (Pelican equipment, Model SCS 6). The percent crude fat was determined by using the following formula:

$$Crude\ Fat\ (\%) = \frac{\text{Wt. of ether extract x } 100}{\text{Wt. of sample}}$$

2.5.5 Crude fiber

Crude fiber of the sample was determined by using fiber plus apparatus. The calculations for crude fiber were done by using the following formula:

$$Crude\ fiber\ (\%) = \frac{W_1 - W_2}{W}\ x\ 100$$

Where,

W_1 = Weight of after oven drying (g)
W_2 = Weight after ashing (g)
W = Initial weight of sample (g)

2.5.6 Nitrogen-free extract

Nitrogen-Free Extract (NFE) was calculated by difference after analysis of all the other items in the proximate analysis.

$$\text{NFE}\ (\%) = 100 - (\%\ \text{moisture} + \%\ \text{crude protein} + \%\ \text{crude fat} + \%\ \text{crude fiber} + \%\ \text{ash})$$

2.5.7 Energy calculation

The percent calories in selected samples were calculated by multiplying the percentage of crude protein and carbohydrate by 4 and crude fat by 9. The values were then converted to calories per 100 g of the sample.

2.6 Sensory Evaluation

Cashew apple powder cookies were prepared in the study and sensory evaluation were carried out after 3 days of cookie preparation using an

untrained and consumer panel of 27 panelists. The food product was rated on a nine-point hedonic scale.

2.7 Colour Analysis

The colour of the cookies was measured by Hunter Lab Scan- XE, on the software Easymathch QC-I, at ICT, Mumbai. The equipment was standardized with standard white tile. The cookies were kept under the aperture of colour measuring device. It represents the colour in L*, a*and b* values. The experiment was repeated three times and the average value was reported. The browning index (BI) was calculated by the formula:

$$\mathrm{BI} = (\Delta \mathrm{L2} + \Delta \mathrm{a2} + \Delta \mathrm{b2})\ 1/2\ x\ 1)$$

Where,

L = Lightness / Darkness
a = Redness / Greenness
b = Yellowness / Blueness

2.8 Textural Analysis

The texture of cookies was measured with QTS Texture Analyser at ICT, Mumbai. The distance between the two beams was 10 mm. The downward movement was continued until the cookies broke. The peak force was reported as fracture strength. The experiment was repeated for thrice times and the average peak force (N) was reported.

3. RESULTS AND DISCUSSION

3.1 Proximate Compositions

The proximate composition of CAP cookies showed significant variation in crude fiber, crude ash and protein content. The crude ash content of the cookies varied from 0.6% (5% CAP) to 1.0% (20% CAP). Higher crude fiber was observed in cookies with 20% CAP (2.04%) and a lower level was detected in biscuits with 5% CAP (0.89%). The protein contact was varied from 8.63% (cookies with 5% CAP) to 6.31% (cookies with 20% CAP). The increase in the crude fiber and ash content can be attributed due to the higher level of fiber in the cashew apple powder. Thus, it can be concluded that fortification positively affected the nutritional quality of cookies as crude fiber and ash content increased significantly as shown by the analysis. The energy content varies from 530.84 (with 10% CAP) to 476.76 cal/100 g (with 15% CAP).

3.2 Sensory Evaluation

The effect of increasing the CAP level on the sensory parameters of the cookies was analyzed. For all the parameters the scores given by the panelist were found in the range of 6.40 to 7.46, which is an acceptable range. Consumer acceptance regarding flavour, taste, appearance and overall acceptability was significantly higher for cookies prepared from 5% CAP varies from those prepared with 10%, 15% and 20% CAP addition. The different treatments i.e. % CAP and baking temperatures had a significant effect on the overall acceptability of cookies at a 5% level of significance with coefficients of variance of 2.538 as shown in Table 4.

3.3 Colour Analysis

The colour measurement of composite cookies substituted with different levels of CAP was determined. From the result, it was noticed that the lightness (L^*) of the composite cookies displayed a decreasing trend along with the increasing substitution level of the CAP (Fig. 3). The L* value indicates that the CAP cookies are darker in colour at a higher level of substitution. The same trend is observed in a* and b* values. The browning index of cookies decreases as the level of CAP increases.

Table 2. Overall proximate composition of cookies

Treatment	Moisture Content (%)	Ash content (%)	Crude proteins (%)	Crude fats (%)	Crude fiber (%)	Nitrogen free extract (%)	Energy content (cal /100 g)
S_1	6.75	0.60	8.63	25.80	0.89	57.32	495.99
S_2	7.38	0.60	7.38	33.50	1.18	49.96	530.84
S_3	7.60	0.60	6.94	23.20	1.62	60.05	476.76
S_4	7.45	1.00	6.31	24.60	2.04	58.60	481.05

Table 3. Sensory evaluation of cookies

Treatment	Appearance	Flavour	Taste	Texture	Overall acceptability
S_1T_1	7.37	7.07	7.04	7.07	7.21
S_1T_2	7.26	6.85	6.67	6.44	6.81
S_1T_3	7.70	7.52	7.41	7.37	7.46
S_2T_1	7.26	7.07	7.19	7.15	7.14
S_2T_2	6.85	7.07	6.78	6.48	6.84
S_2T_3	7.59	7.26	7.33	7.07	7.33
S_3T_1	6.78	7.00	7.00	6.70	6.87
S_3T_2	6.81	6.78	7.00	6.96	6.89
S_3T_3	7.07	7.11	7.26	6.96	7.10
S_4T_1	6.70	6.78	6.52	6.67	6.49
S_4T_2	6.56	6.56	6.30	6.59	6.47
S_4T_3	6.89	6.56	6.44	6.41	6.56

Table 4. ANOVA for the effect of different treatments on overall acceptability

Source	df	SS	MS	F	SEM	CD (5%)
Treatment	11	4.5412	0.4128	13.337**	0.0836	0.292
Replications	3	0.2422	0.0807	2.6086		
Error	33	1.0215	0.0309			
Total	47	5.8049				

*** Significant at 5%, CV=2.538*

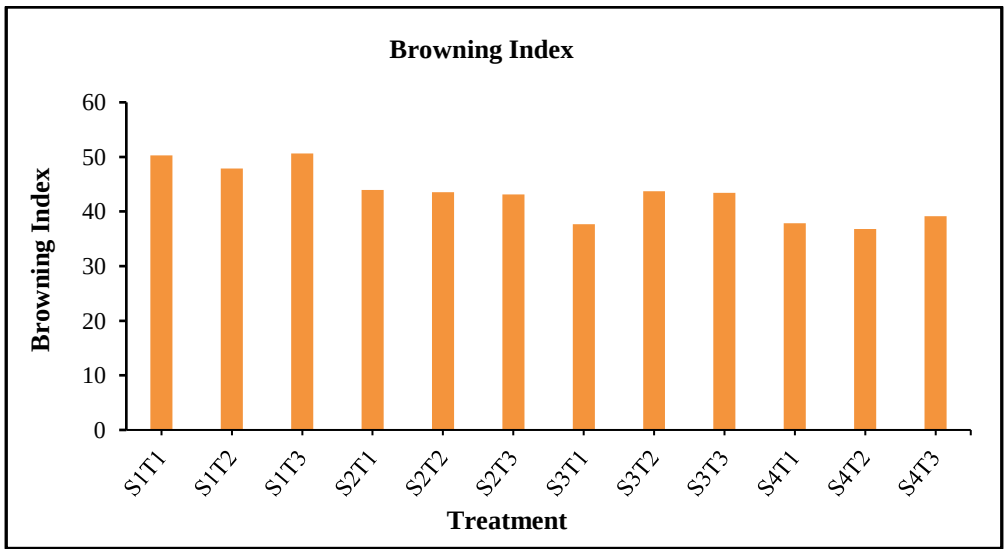

Fig. 3. Effect of CAP on the browning index of cookies

Table 5. Colour analysis of cookies

Treatment	L*	a*	b*	BI
S_1T_1	43.86	9.97	22.09	50.29
S_1T_2	40.82	11.01	21.59	47.87
S_1T_3	44.41	10.14	22.41	50.62
S_2T_1	38.28	9.69	19.28	43.94
S_2T_2	37.45	10.00	19.81	43.53
S_2T_3	37.15	9.94	19.51	43.12
S_3T_1	33.12	8.83	15.63	37.68
S_3T_2	38.97	8.08	18.09	43.72

Treatment	L*	a*	b*	BI
S_3T_3	38.69	8.19	17.99	43.45
S_4T_1	34.36	7.26	14.06	37.83
S_4T_2	32.71	7.67	14.97	36.78
S_4T_3	34.91	7.49	16.00	39.13

Table 6. Textural analysis of cookies

Treatment	Hardness (N)
S_1T_1	9.42
S_1T_2	9.48
S_1T_3	10.18
S_2T_1	7.53
S_2T_2	7.88
S_2T_3	7.62
S_3T_1	7.40
S_3T_2	7.71
S_3T_3	7.34
S_4T_1	7.39
S_4T_2	8.12
S_4T_3	7.41

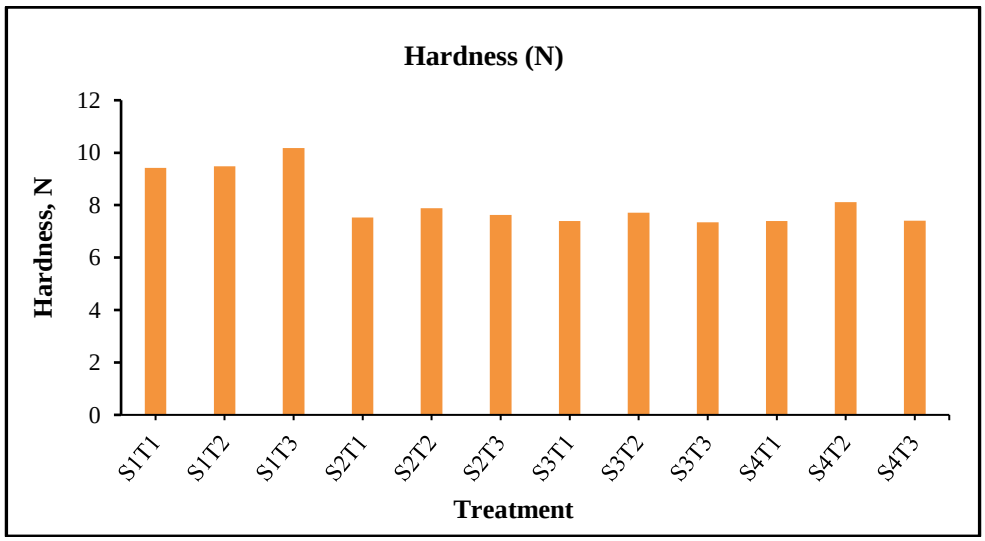

Fig. 4. Effect of CAP on the hardness of cookies

3.4 Textural Analysis

The textural parameters are one of the most important quality attributes, which affect the overall quality and hence demand of cookies. The instrumental textural profile analysis was conducted to confirm and improve the textural properties as obtained from the subjective evaluation of texture. A decreasing trend was observed for hardness when increasing the cap level up to 15% (Fig. 4). The values were found to vary from 7.39 to 10.18 N. From the result, it can be seen that as the level of the CAP increases, the hardness of the cookies decreases.

4. CONCLUSIONS

Cashew apple is a rich source of vitamins, especially vitamin C and after the process of drying the cashew apple powder still can be considered as good source of vitamin C. The bakery industry in India is growing by two-digit numbers i.e. by more than 10% in this century which opens the door for the utilization of CAP in different bakery products. If we replace some amount of maida was replaced by CAP, people would like to consume it more than the other flour cookies. In addition to CAP, crude fiber and crude ash content of the cookies get increased which shows the future scope of CAP for

increasing fiber content in the food products. The different treatments, % CAP and baking temperatures had a significant effect on the overall acceptability of cookies at a 5% level of significance with coefficients of variance of 2.538. Also, the study showed that cookies developed with 5% CAP and baked at a temperature of 180°C (S_1T_3) got the highest score in sensory evaluation (7.46), browning index (50.62) and hardness (10.18 N).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

We hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

We have declared that no competing interests exist.

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