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Nan-khatai: A cassava flour-based cookie

J. Dixit[1], M. Nedunchezhiyan*[1], K. Pati[1], V.B.S. Chauhan[1], K.H. Gowda[1], C. Pradeepika[2], M.S. Sajeev[2] and G. Byju[2]

[1]Regional Station of ICAR-Central Tuber Crops Research Institute, Bhubaneswar 751019, Odisha, India
[2]ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram 695017, Kerala, India

Abstract

Nan-khatai, a bakery product traditionally prepared using refined wheat flour (maida). A study was planned to develop and evaluate nan-khatai using cassava flour. The treatment consisted of combination of refined wheat flour and cassava flour; T_1- refined wheat flour: cassava 100:0, T_2- refined wheat flour: cassava 75:25, T_3- refined wheat flour: cassava 50:50, T_4- refined wheat flour: cassava 25:75 and T_5- refined wheat flour: cassava 0:100. The developed product was tested for sensory evaluation. Using 9-point hedonic scale, sensory evaluation was carried out for (i) appearance or colour, (ii) taste and flavor, (iii) smell or odour, (iv) texture or mouth feel or sweetness. As per score card, the product with combination of refined wheat flour and cassava flour in the ratio of 100:0 (T_1), 75:25 (T_2) and 50:50 (T_3) were liked very much (LVM) on the basis of appearance, taste, smell, texture or mouthfeel. The a combination of refined wheat flour and cassava flour 25:75 (T_4) was liked moderately (LM) for the above sensory parameters. The combination ratio of refined wheat flour: cassava 0:100 (T_5) was liked slightly. The outcome of this research can be used as valuable ideas for the development of high-fibre low gluten cookies.

Keywords: Cassava, Density, Nan-khatai, Spread ratio, Volume

Introduction

Bakery industry in India is considered as one of the major food processing industry with a market value of 12.6 billion US $ in 2023. International market analysis research and consulting (IMARC) group expects the market to reach 29.4 billion US $ by 2032, exhibiting a compound annual growth rate (CAGR) of 9.6% during 2024-2032 (IMARC, 2013). The growing population and changing consumer preferences driven by factors such as western food trends, the growth of the organized bakery sector is set to increase by 70% in 2030 (WFI, 2023) as the companies are spending a lot in research and development, skill development, launching of innovative products. Growing population and urbanizing, the Indian bread and bakery industry is likely to experience healthy growth in the coming years. Increasing health awareness among urban population has spurred innovation and healthy alternatives like gluten free, sugar free and fortified bakery consumables. India is known to be the second largest manufacturer of biscuits and other bakery products for their availability, ready to eat convenience, and comparatively good shelf life.

Cassava (*Manihot esculenta* Crantz) is one of the most important starch resources, because it can be grown under harsh climatic conditions. Cassava can be cultivated in both tropical and subtropical regions and has become a staple food in those regions. Cassava and other tropical root and tuber crops serve as the third most important food source in the tropics after cereal crops such as rice and maize because of its high starch content (Dudu et al., 2019; Heny et al., 2015). Cassava is a robust crop that gives a high root tuber yield, even under marginal growing

* Corresponding author
E-mail: m.nedunchezhiyan@icar.org.in ; Ph: +91 7978488514

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conditions. The main constituents in cassava roots are water (60 g 100 g^{-1}) and carbohydrates (38 g 100 g^{-1}), while the content of proteins, fat and fibers is limited (1.4, 0.28 and 1.8 g 100 g^{-1}, respectively) (Sidsel et al., 2015). The above-mentioned percentages are approximations as large variations between and within cultivars exist (Aryee et al., 2006). The starch concentration is generally higher than in wheat (Raeker et al., 1998), while the protein level is significantly lower than the 7–14% found in wheat (Gupta et al., 1993). Cassava roots are rich in carbohydrates, which are 40% and 20% higher than rice and corn, respectively (Bala et al., 2015).

Cassava has been exploited as a raw material for human food production, animal feed, industry, and alternative fuels. Cassava root has various health benefits in healthy digestion and maintaining body balance. Rich source of fibre and the easy digestive nature of this root have proven benefits for sensitive digestive system and enhance easy digestion. Low-GI properties of cassava root can help improve physical endurance of body, blood glucose levels are moderated instead of droppingwhen insulin is produced. Cassava has even been called a 'weight loss wonder food' due to its ability to decrease appetite and fat storage in fat cells as part of a daily healthy diet. Among the roots and tubers, cassava is suitable for partial or complete replacement of wheat flour, because of its high yield, low cost of production, and the unique functional properties of its flour and starch (Akingbala et al., 2011; Gyedu-Akoto and Laryea, 2013).

Fresh cassava roots are difficult to store and usually have a short shelf life of only 2-3 days after harvest because of physiological deterioration (Nedunchezhiyan and Sahoo, 2019). Therefore, flour making is a good method for storage ofroots for longer use. Cassava flour is prepared by peeling, crushing, and drying. The production of cassava flour can prolong the shelf-life of cassava and further reduce cyanide glucosides content to safe levels (Fukushima et al., 2016). Cassava flour having good nutritional advantage of natural starch, high water-binding ability, high fibre and comparatively more mineral content compared with cereal flours. Numerous studies and applications demonstrated the feasibility of partially replacing wheat flour with cassava flour in cakes (Navacchi et al., 2012), biscuits (Chakrabarti et al., 2017), bread (Aristizábal et al., 2017), and noodles (Abidin et al., 2013). Compared with wheat products, the food produced with cassava flour provided more carbohydrates and low lipid and protein content (Navacchi et al., 2012). The research indicated that the inclusion of cassava flour in cookies production led to a less significant glycemic response (Okafor et al., 2017).

An approach in the present study was to replace refined wheat flour in cookies by cassava flour (gluten free flour) in order to increase the fibre and other nutrients and Bengal gram flour further increase the protein availability, dietary fiber as well as mineral content. The objective was to develop nan-khatai cookies with good taste texture and appearance, which resembles as closely as possible to the traditionally prepared refined wheat flour-based product.

Materials and Methods

The experimental studies were carried out in Techno Incubation Centre of Regional Centre of Central Tuber Crops Research Institute, Bhubaneswar. Fresh tubers of Short duration cassava (variety: Sree Jaya) were procured from the Regional Centre of ICAR-CTCRI, Bhubaneswar. Cassava flour was prepared by following the procedure given in the flow chart (Fig. 1). The cassava roots were thoroughly washed, peeled, sliced, blanched,

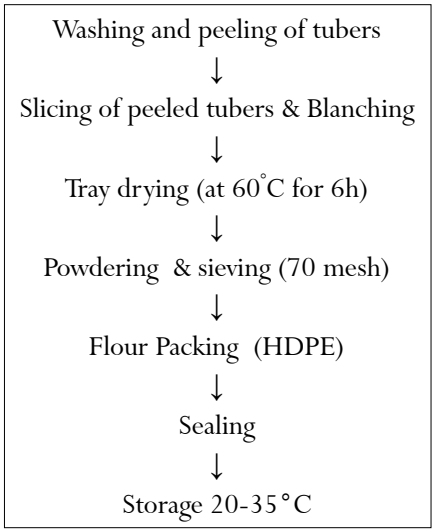

Fig. 1. Flow chart for the preparation of cassava flour

dried and milled into flour. The cassava flour stored in non-transparent airtight containers for longer shelf life. The flour can be stored for six months or more in sealed containers. Other good quality raw materials such as refined wheat flour, Bengal gram flour, ghee, sugar and baking powder were procured from the market.

Nan-khatai product development planning was given in the Table 1. Five types of nan-katai were developed with the of combination of refined wheat flour and cassava root flour in different ratio (Table 2) *i.e.,* T_1- refined wheat flour: cassava 100:0, T_2- refined wheat flour: cassava 75:25, T_3- refined wheat flour: cassava 50:50, T_4- refined wheat flour: cassava 25:75 and T_5- refined wheat flour: cassava 0:100. Apart from cassava and wheat flour other ingredients also added to enhance nutrition and quality while preparing nan-khatai. The details of ingredients in each treatment were given in the Table 3. The flow chart for the preparation of nan-khatai was given in Fig. 2. The treatments were replicated five times.

Table 1. Product development planning

Sl. No.	Parameter	Level	Description
1	Product	1	Nan-khatai
2	Ingredients	5	Refined wheat flour, cassava flour, Bengal gram flour, ghee, sugar and baking soda
3	Sample Type	5	T_1, T_2, T_3, T_4 and T_5
4	Analysis	1	Sensory evaluation
5	Packaging material	1	HDPE stand up pouch
6	Storage condition	1	Ambient temperature

Table 2. Different combinations of cassava and refined wheat flour for nan-khatai production

Treatment	Cassava Flour (%)	Refined wheat flour (%)
T_1	00	100
T_2	25	75
T_3	50	50
T_4	75	25
T_5	100	00

Table 3. Ingredients used in the preparation of nan-khatai cookies

Sl. No.	Ingredients	T_1	T_2	T_3	T_4	T_5
1	Cassava flour (g)	00	120	80	40	00
2	Refined wheat flour (g)	160	40	80	120	160
3	Bengal gram flour (g)	40	40	40	40	40
4	Sugar (g)	100	100	100	100	100
5	Ghee (g)	70	70	70	70	70
6	Baking powder (g)	2	2	2	2	2
7	Salt (g)	0.5	0.5	0.5	0.5	0.5

The physico-chemical properties of cassava flour and the physical parameters of nan-kataiwere estimated by following the method of AACC (2000). The sensory evaluation was carried out using 9-point Hedonic scale (Amerine et al., 1965) for (i) appearance or colour, (ii) taste and flavor, (iii) smell or odour, (iv) texture or mouth feel or sweetness and (v) overall acceptability (OAA) (Table 4). Sensory evaluation test was carried out using 25 participants.

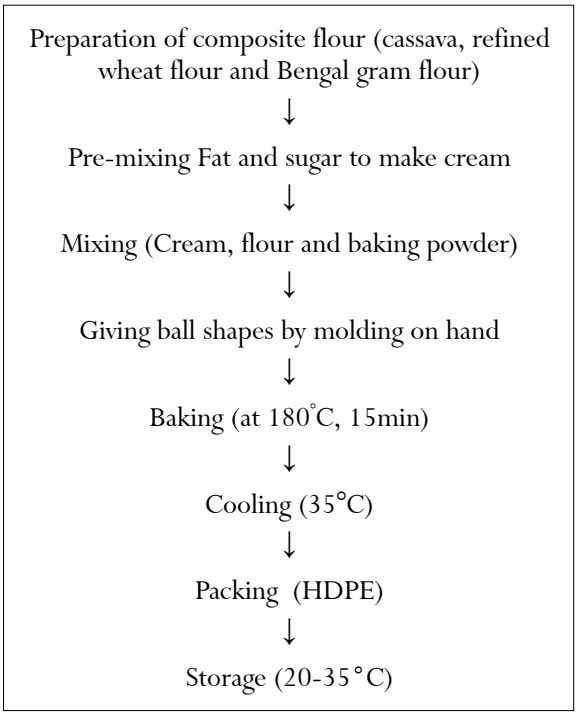

Fig. 2. Flowchart for the preparation of nan-khatai

Table 4. Rating based on organoleptic score using 9-point Hedonic scale

Organoleptic score	Scale (Rating)
9-10	Liked extremely (LE)
8-9	Liked very much (LVM)
7-8	Liked moderately (LM)
6-7	Liked slightly (LS)
5-6	Neither liked nor disliked (NLND)
4-5	Disliked slightly (DS)
3-4	Disliked moderately (DM)
2-3	Disliked very much (DVM)
1-2	Disliked extremely (LE)

Results and Discussion

Physico-chemical analysis of cassava flour (variety Sree Jaya) revealed that it contains moisture 8.2%, carbohydrate 87.2%, starch 72.8% and crude fibre 1.95% (Table 6). The above said cassava flour was used for developing nan-khatai.

Table 6. Physico-chemical analysis of the developed cassava flour

Sl. No.	Constituent	Percentage (%)
1	Moisture	8.2 ± 0.2
2	Carbohydrates	87.2 ± 0.1
3	Starch	72.8 ± 0.4
4	Crude fibre	1.9 ± 0.08
5	Fat	0.25± 0.06

The dough 30±1.4 g was baked at 180°C for 15 min and resulted in 20 ± 0.6 g nan-khatai. The physical parameters of the developed nan-khatai cookies were presented in Table 7. The diameter of the nan-khatai was not significantly influenced by the treatments. However, the treatment T_1 resulted in higher diameter. The thickness of the nan-khatai was significantly influenced by the treatments. The treatment T_1 and T_2 resulted in higher thickness and it was comparable with T_3. The treatment T_4 and T_5 resulted in lower thickness. The volume of the nan-khatai was significantly influenced by the treatments. The treatment T_1 resulted in higher volume. However, it was comparable with T_2. The volume of T_3 was comparable with T_2. The treatment T_1 resulted in lower density. However, it was statistically comparable with T_2 and T_3. The incorporation of cassava flour resulted in linear decrease of diameter, thickness and volume, and increase of density. This may due to the higher water holding capacity and fibre content of cassava flour. Chakrabarti et al., (2017) reported the feasibility of partially replacing wheat flour with cassava flour in biscuits.

Table 7. Physical properties of the developed nan-khatai cookies

Treatment	Diameter (cm)	Thickness (cm)	Volume (cm^3)	Density ($g\ cm^{-3}$)
T_1	4.0	2.0	24.14	0.83
T_2	3.9	2.0	23.88	0.84
T_3	3.8	1.9	21.54	0.88
T_4	3.9	1.8	21.49	0.97
T_5	3.8	1.8	20.40	0.98
CD (p =0.05)	0.2	0.1	1.32	0.06

Sensory evaluation was carried out for the developed nan-khatai cookies (Table 8). The treatment T_1 resulted in higher score and rated LVM for colour/ appearance. The treatments T_2, T_3 and T_4 resulted in LM rating for colour/ appearance. The treatments T_2, T_1 and T_3 resulted in LVM rating for smell of nan-khatai. The treatment T_3 resulted in LE rating for flavour. The treatments T_1, T_2 and T_4 resulted in LVM rating for flavour. The treatments T_1, T_2 and T_3 resulted in LVM rating for texture. The treatment T_4 resulted in LM rating for texture. The treatment T_5 resulted in LS rating for colour/ appearance, smell, flavour and texture. The treatments T_1, T_2 and T_3 resulted in LVM rating for OAA. The treatments T_4 resulted in LM rating for OAA. The treatments T_5 resulted in LS rating for OAA. Thus, incorporation/ substitution of cassava flour 25-50% level to refined wheat flour did not affect the sensory attributes colour, smell, flavour, texture and overall acceptability of nan-khatai cookies.

Table 8. Sensory evaluations of nan-khatai cookies

Treatment	Colour/ Appearance	Smell	Flavour	Texture	OAA
T_1	8.2	8.3	8.8	8.5	8.3
T_2	8.0	8.5	9.0	8.3	8.3
T_3	7.7	8.3	9.2	8.1	8.1
T_4	7.2	7.8	8.0	7.4	7.5
T_5	6.5	6.3	6.6	6.0	6.2
CD (p =0.05)	0.4	0.3	0.6	0.4	0.3

Conclusion

Cassava is a rich source of dietary fibre and carbohydrate. It is proven to be beneficial when used in combination with refined wheat flour for bakery products as nutrition supplement. Combination of cassava flour with refined wheat flour had significant effect on physical properties of nan-khatai cookies. Incorporation/ substitution of cassava flour 25-50% level to refined wheat flour did not affect the sensory attributes colour, smell, flavour, texture and overall acceptability of nan-khatai cookies. The results of nan-khatai cookies production could be very useful for industries interested in production of innovative, healthy products as alternative or supplement to cereal flours. Cassava flour could be useful in the manufacture of highly nutritious cookies.

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