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Studies on physicochemical, nutritional and sensory characteristics of Bamboo sprouts powder incorporated Biscuit

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Abstract

Bamboo sprouts are a nutritious food rich in protein and dietary fibre, low in carbohydrates and fats, and with good mineral and vitamin profiles. Present study focused on the use of bamboo sprouts powder for the production of baked goods owing to their enormous health benefits. Formulations were developed with different proportions of refined wheat flour, Bamboo sprout powder and Sprouted soya bean flour in the ratios T₀100% Refined Wheat Flour (100%), T₁ 40% Refined Wheat Flour: Bamboo sprouts powder, Sprouted Soy Bean Flour (40:40:20), T₂ Refined Wheat Flour: Bamboo sprouts powder: Sprouted Soy Bean Flour; (50:30:20) and T₃ Refined Wheat Flour: Bamboo sprouts powder: Sprouted Soy Bean Flour; (50:40:10) respectively. The biscuits weight ranged from 10.62g to 11.14g with biscuits that contained the highest percentage of bamboo sprouts powder (T₃) having the least weight while biscuits with the least percentage of bamboo sprouts powder (T₁). The diameter and thickness of the produced biscuits ranged from 44.62 to 4.89 (cm) and from 1.33 to 1.45(cm) respectively. The moisture content was ranged from 5.73 to 6.58. The control (T₀) had the high moisture content 5.73% on the initial day of analysis. At the end of the storage period (45 days) the moisture content was lower in T₂ (6.02%) sample. Initially the protein content was ranged from 7 to 9% of control and 24 to 26.5% in T₂ samples. Initially the fat content maintained from 29 to 32 per cent. The T₂ had the highest fat content 32 per cent on the initial day of analysis and the T₁ control treatment had the minimum fat content of 29 per cent. The initial crude fiber content was maintained from 2.74 to 3.3 per cent. The T₂ had the highest crude fiber content 3.5% on the initial day of analysis and the T₀ control treatment had the minimum crude fiber content of 2.74%. The free fatty acid content of bamboo shoot biscuits ranged from 0.12 to 0.32%. The sensory evaluation for colour, flavor, taste texture and overall acceptability were high in biscuits. The microbial load viz., total plate count, yeast and mould count of bamboo sprouts flour biscuits was Below Detectable Level (BDL) on 0 day (initial) of storage period. At the end of the 45 days of storage, the bamboo shoot flour biscuits showed high in total plate count (8 cfu/ml) of T₁ sample when compared to T₁₂ sample. Bamboo sprouts that are rich in nutrients and bioactive compounds can be used for the enrichment of bakery products such as biscuit to produce healthy snacks.

Keywords: Bamboo sprouts, Processing, Fortification, Biscuit, sensory and microbial quality

Introduction

Bamboo is one of the most economically important plants in the world as every part of the plant - culm, rhizome, root, leaves and young shoots can be used for different purposes. It is mostly known for its industrial uses but less recognized as a source of food or medicine. Today, it helps more than 2 billion people meet their basic needs and as a widespread, renewable, productive, versatile, low- or no-cost, easily accessed, environment-enhancing resource; it has great potential to improve life, especially in the rural areas of the developing world (Sastry, 2020) ^[11]. Bamboos are gaining increased attention as an alternative crop with multiple uses and benefits, providing human beings with various living resources. They are intermixed with the tradition and culture

of rural and tribal populations and are an integral part of their cultural, social, and economic conditions.

Bamboo sprouts are not only delicious but are rich in nutrient components, mainly proteins, carbohydrates, minerals, and fiber and are low in fat and sugars. In addition, they contain phytosterols and a high amount of fiber that can be labeled as nutraceuticals or natural medicines that are attracting the attention of health advocates and scientists alike. The sprouts are free from residual toxicity and grow without the application of fertilizers (Younas *et al.*, 2019) ^[16]. Modern research has revealed that bamboo sprouts have a number of health benefits: improving appetite and digestion, weight loss, and curing cardiovascular diseases and cancer. The sprouts are

reported to have anticancer, antibacterial, and antiviral activity. Sprouts have antioxidant capacity due to the presence of phenolic compounds. The increasing trends of health consciousness among consumers have stimulated the field of functional foods and bamboo sprouts can be one of them. Bamboo fiber is now a common ingredient in breakfast cereals, fruit juices, bakery and meat products, sauces, shredded cheeses, biscuits, pastas, snacks, frozen desserts, and many other food products (Nirmala *et al.*, 2019)^[8].

Biscuits are popular snack foods that are widely consumed by people of all ages due to their affordability, convenience, long shelf life and nutritional value. Traditionally, biscuits are made from wheat flour but could also be made from other flours. Also, since biscuits widely accepted and consumed by people of all ages, therefore offer a valuable supplementation vehicle for nutritional improvement. The incorporation of nutritionally rich ingredients for making bakery products is a common practice. Biscuits are convenient and inexpensive bakery products consumed by all ages. The enrichment of nutrients and bioactive compounds in biscuits may be achieved through the incorporation of natural sources rich in these compounds.

Material and Methods

Materials

Bamboo sprouts were purchased from Department of forestry, Madurai. Non-perishable items Spices, oil and Sodium benzoate (KMS) were purchased in bulk from the local market. Glass bottles (capacity 200 ml) with caps were used for storing the prepared bamboo shoot flour biscuits.

Physical properties of biscuit

The physical properties of control and yam biscuits were analyzed for its weight using balance and cookie dimensions

for the thickness (the distance between top and bottom surface of cookie) and width (distance across the cookie) were determined using Vernier caliper. The diameter (D), thickness (T) and spread factor of the biscuits prepared from control and treatment samples were measured and calculated according to their corresponding protocols described in AACC, (2000).

Methods

b) Bamboo sprouts powder biscuits

Biscuits contains many of the same ingredients as cake except that they have a lower proportion of liquid that means water or no liquid with higher proportion to sugar and fat to flour. Traditionally, biscuits are made from wheat flour but could also be made from other flours. Also, since biscuits widely accepted and consumed by people of all ages, therefore offer a valuable supplementation vehicle for nutritional improvement. So that the protein enriched biscuits have been developed using Bamboo sprouts flour, Sprouted soya bean flour and refined wheat flour. Four formulations were developed with different proportions of refined wheat flour, Bamboo sprouts flour and Sprouted soya bean flour in the ratios of 100%, 40:40:20, 50:30:20, and 50:40:10 T₀, T₁, T₂ and T₃ respectively. Sample T₀ served as control. The biscuits were stored safely in Low Density Polyethylene (LDP) -P1 and aluminum foil (P2). The storage study was done for 45 days.

- T₀=100% Refined Wheat Flour (100%)
- T₁=40% Refined Wheat Flour: Bamboo sprouts powder: Sprouted Soy Bean Flour (40:40:20)
- T₂= Refined Wheat Flour: Bamboo sprouts powder: Sprouted Soy Bean Flour; (50:30:20)
- T₃= Refined Wheat Flour: Bamboo sprouts powder: Sprouted Soy Bean Flour; (50:40:10)

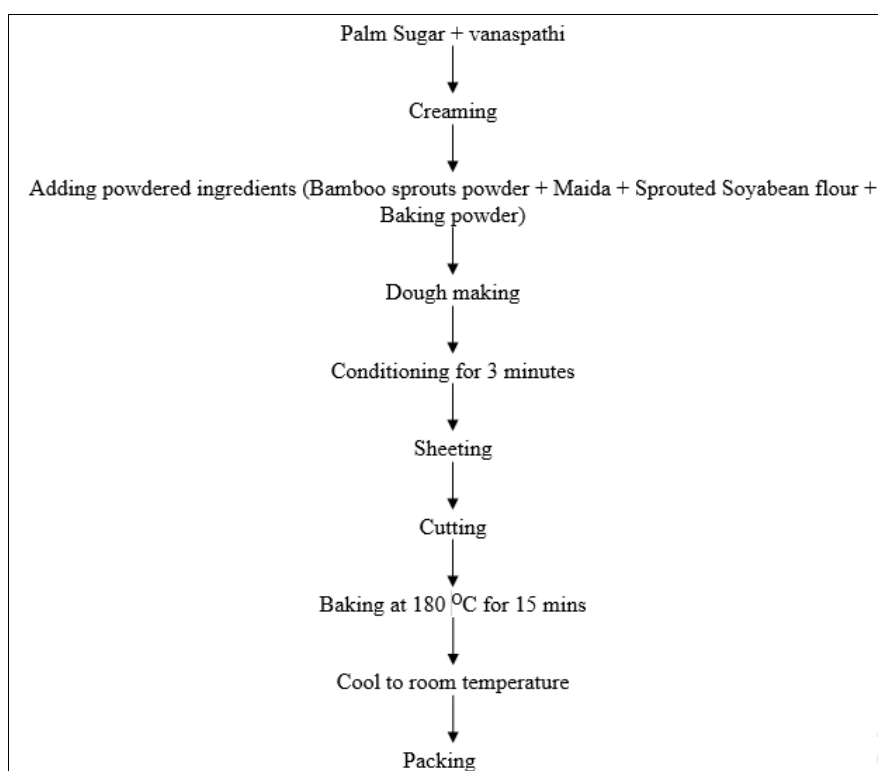


Fig 1: Flow chart for developed bamboo sprout powder biscuits

Physicochemical and nutritional composition analysis

The following analytical methods were employed to evaluate the physicochemical properties of finger millet milk samples: The pH was measured using a digital hand-held pH meter. Total acidity was estimated following the procedure described by Ranganna (1986). Moisture protein and carbohydrate of the sample was estimated by the Ranganna (1995)^[9]. The pH of the sample was estimated by the method described by Hart and Fischer (1971)^[3]. The microbiological load of the stored sample was enumerated at regular intervals by the methods described by Istawankiss (1984)^[4].

Sensory evaluation

The control and bamboo sprouts powder incorporated biscuit samples were subjected to sensory evaluation by a panel of 15 semi-trained members using a 9-point Hedonic rating scale, as outlined by Ranganna (1986). The sensory assessment covered attributes such as colour and appearance, flavour, taste, consistency, and overall acceptability. Each parameter was rated on a scale where 1 indicated “extremely dislike”, 5 denoted “neither like nor dislike”, and 9 represented “extremely like.”

Statistical analysis

The data obtained from the various experiments were subjected to statistical analysis to find out the impact of storage condition used and storage period. Completely Randomized Design (CRD) was applied for the analysis of the study as described by Rangaswamy (1995)^[10].

Results and Discussion

Physical analysis of biscuits

The physical properties of control and bamboo sprout powder biscuits were analyzed for its weight using balance

and biscuit dimensions for the thickness (the distance between top and bottom surface of biscuit) and width (distance across the biscuit) were determined using Verniercaliper (Table 1).

Spread ratio

The spread ratio of the baked biscuits were determined from the ratio of width and thickness of biscuits. The physical characteristics of the prepared biscuits varied with the variation in the proportion of individual flours in the different blends (Table 1). The biscuits weight ranged from 10.62g to 11.14g with biscuits that contained the highest percentage of bamboo sprouts (T_3) having the least weight while biscuits with the least percentage of bamboo sprouts flour(T_1). The diameter and thickness of the produced biscuits ranged from 4.62 to 4.89 (cm) and from 1.33 to 1.45(cm) respectively. These variations in biscuits diameter and thickness are reflected in the spread ratio which was calculated by dividing diameter by thickness of the biscuits. Spread ratio of biscuits has long been used as an important characteristic for determining the quality of flour for biscuits production. Biscuits with higher values of spread ratio are considered to be more desirable than those with lower values. In the present study, biscuits prepared from the composite flour with 50% bamboo shoot flour addition (T_2) had the highest spread ratio (3.55) while the least value (3.25) was recorded for the biscuits from the blend without soya bean sprouted flour (T_3).

Table 1: Physical properties of bamboo sprout biscuit

Parameters	T_0	T_1	T_2	T_3
Weight(g)	10.62	10.53	10.06	11.14
Diameter(cm)	4.89	4.83	4.73	4.62
Thickness(cm)	1.45	1.39	1.33	1.42
Spread ratio (D/T)	3.34	3.47	3.55	3.25

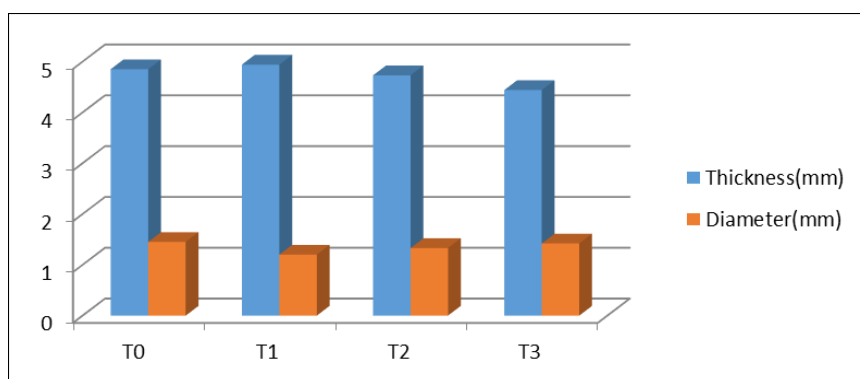


Fig 2: Physical parameter of bamboo sprouts biscuits

Proximate composition of bamboo sprout powder biscuits:

Moisture and protein

The moisture content was ranged from 5.73 to 6.58. The control (T_0) had the high moisture content 5.73% on the initial day of analysis (Table 2.). At the end of the storage period (45 days) the moisture content was lower in T_2 (6.02%) sample. Based on the results of moisture content of different packaging materials and different storage days, the moisture content was getting increased due to transpiration of packaging which was highly occurred in P_2 due to high

transpiration than the P_1 . The statistical analysis showed that there was no significant change in the packaging materials and storage period.

Initially the protein content was ranged from 7 to 9% of control and 24 to 26.5% in T_2 samples Table 2.) But the 45 day storage results showed that the protein content ranged from 21 to 24 in P_1 and 20 to 24 in P_2 samples. Based on the results of protein content of different packaging materials and different storage days, the protein content was getting decreased. T_2 has highest protein content than other treatments because of high composition of SSBF than other composite treatments. The lowest protein content was

present in T₀ due to the flour composite.

The statistical analysis revealed that there was a significant changes in treatments tried, packaging materials and storage period.

Fat and free fatty acid

Initially the fat content maintained from 29 to 32 per cent (Table 3.). The T₂ had the highest fat content 32 per cent on the initial day of analysis and the T₁ control treatment had the minimum fat content of 29 per cent. But the 30th day analysis results revealed that the fat content ranged from 26 to 29 per cent in P₁. Highest fat content of P₁ was T₃ and lowest fat content of P₁ was T₂. In P₂ the fat content lied from 25 to 26.5 per cent. Highest fat content of P₂ was T₁ and lowest fat content of P₂ was T₂. On the 45th day of analysis showed the results that the fat range in P₁ from 24

to 25 per cent and in P₂ the fat content maintained between 21 to 24.5 per cent. Based on the results of fat content of different packaging materials and different storage days, the fat content was getting decreased due to the oxidation of fat to fatty acids.

The statistical analysis revealed that there was a significant change in treatments tried, packaging materials and storage period.

The free fatty acid content of bamboo shoot biscuits ranged from 0.12 to 0.32%(Table 3). The control (T₀) had the high free fatty acid content 0.16% on the initial day of analysis and the T₂-treatment had the minimum free fatty acid content of 0.12%. At the end of the final (45th day) free fatty acid content was increased (control 0.16 to 0.32 and T₃: 0.12 to 0.19%).

Table 2: Change in Moisture and protein content (%) of Bamboo spouts powder biscuit during storage

Treatments	Moisture content (%)								Protein content (%)							
	T ₀		T ₁		T ₂		T ₃		T ₀		T ₁		T ₂		T ₃	
Packaging	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂
0 th Day	5.73	5.73	5.85	5.85	5.94	5.94	6.08	6.08	9.0	9.0	24	24.0	26.5	26.5	18.0	18.0
30 th Day	5.92	5.86	5.92	5.85	6.07	5.98	6.19	6.14	8.0	7.5	22	21.5	27.0	26.5	16.0	15.0
45 th Day	6.58	6.34	6.10	6.04	6.21	6.02	6.31	6.18	7.5	7.0	21	20.0	25.0	24.0	15.5	13.0

Low Density Polyethylene (LDP) -P₁ and aluminum foil (P₂)

S.D.A	Moisture
S	0.0247*
T	0.02255*
P	0.01426*
ST	0.07812NS
SP	0.07812NS
STP	0.07812NS

*	-	Significant
**	-	Highly Significant
NS	-	Non Significant

S.D.A	Protein
S	0.02655*
T	0.02423*
P	0.01533NS
ST	0.08395NS
SP	0.08395NS
STP	0.08395NS

*	-	Significant
**	-	Highly Significant
NS	-	Non Significant

Total Carbohydrate and crude fibre

Initially the total carbohydrate content was ranged from 40 to 43 per cent (Table 4) In control sample The T₂ had the lowest total carbohydrate content (26.12%). at the end of 45 days of storage the total carbohydrate content was slightly decreased. on the results of total carbohydrate content of different packaging materials and different storage days, the total carbohydrate content was getting decreased.

The statistical analysis revealed that there was a significant change in treatments tried, packaging materials and storage period.

The initial crude fiber content was maintained from 2.74 to 3.3 per cent (Table 4.). The T₂ had the highest crude fiber content 3.5% on the initial day of analysis and the T₀ control treatment had the minimum crude fiber content of 2.74%.

But the 30th day analysis results revealed that the total crude fiber content ranged from 2.5% to 3.3% in P₁. Highest crude fiber content of P₁ was T₂ (3.3%) and lowest crude fiber content of P₁ was T₀ (2.5%). In P₂ the crude fiber content lied from 2.3% to 3.25%. Highest crude fiber content of P₂ was T₂ (3.25%). Lowest crude fiber content of P₂ was T₀ (2.3%). On the 45th day of analysis showed the results that the crude fiber range in P₁ from 2.35% to 3.15%. Based on the results of crude fiber content of different packaging materials on different storage days, the crude fiber content was getting decreased due to heat breakage of weak bonds between polysaccharides.

The statistical analysis revealed that there was a significant changes in treatments tried, packaging materials and storage period.

Sensory Evaluation

The bamboo sprouts powder biscuits were organoleptically evaluated by using a panel of ten untrained judges with 9 to 1 hedonic scale (Table 5.). The sensory attributes viz., colour and appearance, flavour, taste, texture and overall acceptability of the bamboo sprout powder biscuits showed light variation. Mean scores of sensory attributes of biscuits (1st, 30th and 45th day) evaluated are presented in Table 5.

Bamboo sprout biscuits T₃ sample had the lowest score (7) for flavor, Taste and overall acceptable, The incorporation of bamboo sprout powder and sprouted soybean flour into refined-wheat flour biscuits resulted in better taste and aroma scores. SampleT₀ had the lowest values of 7 for both taste and aroma, while sample T₂ had the highest scores of 8 for taste and aroma. Most of the panelist accepted the taste of palm sugar.

Table 3: Change in fat and free fatty acid content (%) of Bamboo spouts powder biscuit during storage

Treatments	Fat (%)								Free fatty acid (%)							
	T ₀		T ₁		T ₂		T ₃		T ₀		T ₁		T ₂		T ₃	
Packaging	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂
0 th Day	30	30	29	29	32	32	30	30	0.16	0.16	0.14	0.14	0.12	1.2	0.12	0.12
30 th Day	27.5	25.5	26	25	29	26.5	26.5	25	0.28	0.28	0.25	0.25	0.20	0.18	0.17	0.17
45 th Day	25	23	24	21	25	24.5	24	23.5	0.32	0.32	0.27	0.25	0.22	0.20	0.19	0.19

Low Density Polyethylene (LDP) -P1 and aluminum foil (P2)

S.D.A	Fat
S	0.06524*
T	0.05945*
P	0.03762*
ST	0.20662*
SP	0.20662*
STP	0.20662*

*	-	Significant
**	-	Highly Significant
NS	-	Non Significant

	SED	CD (0.05%)
P	0.0006	0.00133
S	0.0006	0.00133
PXS	0.0008	0.0019 _{NS}

*	-	Significant
**	-	Highly Significant
NS	-	Non Significant

Table 4: Change in Total Carbohydrate and crude fibre content (%) of Bamboo spouts powder biscuit during storage

Treatments	Total Carbohydrate (%)								Crude fiber content (%)							
	T ₀		T ₁		T ₂		T ₃		T ₀		T ₁		T ₂		T ₃	
Packaging	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂	P ₁	P ₂
0 th Day	43	43	28.4	28.4	26.12	26.12	26.86	26.86	2.74	2.74	3.2	3.2	3.5	3.5	3.3	3.3
30 th Day	41	41	28.4	28.4	26.08	26.10	26.86	26.86	2.5	2.3	3.1	3.05	3.3	3.25	3.25	3.15
45 th Day	40	40	27.48	27.26	25.84	25.92	26.14	26.4	2.35	2.2	3	2.9	3.15	3.0	3.1	3.05

Low Density Polyethylene (LDP) -P1 and aluminum foil (P2)

S.D.A	Total Carbohydrate
S	0.04778*
T	0.03634*
P	0.02235*
ST	0.12141NS
SP	0.12141NS
STP	0.12141NS

*	-	Significant
**	-	Highly Significant
NS	-	Non Significant

S.D.A	Crude fibre
S	0.06534*
T	0.05965*
P	0.03772*
ST	0.20662NS
SP	0.20662NS
STP	0.20662NS

*	-	Significant
**	-	Highly Significant
NS	-	Non Significant

Table 5: Organoleptic evaluation of Bamboo sprouts powder biscuit

Organoleptic evaluation	T ₀	T ₁	T ₂	T ₃
Colour & Appearance	8.0	8.0	8.0	8.0
Flavour	7.0	7.0	7.5	7.0
Texture	7.5	8.0	7.5	7.5
Taste	7.0	8.0	8.0	7.0
Over all acceptability	7.5	7.5	8.0	7.0

Microbial load

The microbial load viz., total plate count, yeast and mould count of bamboo sprout powder biscuits was Below Detectable Level (BDL) on 0 and 30th day of storage period.

(Table 6). At the end of the 45 days of storage, the bamboo sprout powder biscuits showed high in total plate count (8 cfu/ml). So storage study of the biscuits was acceptable for 30 days.

Table 6: Microbial load of Bamboo sprouts powder biscuit

Microbial load	Yeast & Mold (cfu/ml)	Total Plate Count (cfu/ml)	Yeast & Mold (cfu/ml)	Total Plate Count (cfu/ml)
Day	0 th		45 th	
Dilutions	10 ³	10 ⁵	10 ³	10 ⁵
T ₀	BDL	2	6	7
T ₁	BDL	2	6	8
T ₂	BDL	2	4	7
T ₃	BDL	2	6	7

	SED	CD (0.05%)
P	0.47871	1.10393
S	0.47871	1.10393
PXS	0.67700	1.56119 _{NS}

*	-	Significant
**	-	Highly Significant
NS	-	Non Significant

Conclusion

Bamboo sprouts powder biscuit were a rich source of nutrients and health promoting bioactive compounds such as phenols, phytosterols, and dietary fiber. Bamboo sprouts, considered as a 'superfood' are a good source of nutrients and health-promoting bioactive compounds. Bamboo is one such plant popularly known for its industrial uses but the consumption of young shoots as food remains neglected. The emerging evidence indicates that bamboo sprout fortification in making common food products have the potential to nourish the malnourished population. Fortification protein enriched biscuits with bamboo shoot was found to be acceptable up to 30 per cent in powder form respectively. The sensory evaluation for colour, flavor, taste texture and overall acceptability were high in biscuits. The bamboo sprout fortified biscuits was significantly lower and below the permissible level of intake. Hence, processed bamboo sprouts powder biscuit can be safely used for making nutritionally rich functional bamboo sprout powder biscuits.

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