

Sensory Properties and Microbial Characteristics of Cookies Prepared from Refined Wheat Flour Supplemented With Sweet Potato Flour and Whey Protein Concentrate

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Abstract: A study was conducted for sensory analysis and microbial assay for the cookies supplemented with refined wheat flour, sweet potato flour and whey proteins concentrate (WPC-80). The cookies made were nutritious products for all peoples. The product on the whole composed of sweet potato flour, whey protein concentrate (WPC-80), refined wheat flour and other ingredients such as butter and sugar. The product was made with different formulations. Sensory evaluation was done for acceptability of the product and microbial study was conducted for the developed cookies. Results from sensory analysis revealed that all treatment combinations are in acceptable level. Among all, T₃ HT1 (20% SPF and 20% WPC) scored best in overall acceptability. The SPC ranges from 1.400±0.548 to 4.400±0.548 from 0th to 30th days, Yeast and mould was NIL in 0th and 15th day on 30th it was recorded. Coli forms count is NIL in 0th day and it was recorded in 15th and 30th days for different treatment combination.

Key words: Sweet Potato Flour, Whey Protein Concentrate, Cookies Sensory Evaluation, Microbial Assay

Introduction:

The sweet potato *Ipomoea batatas* (L.) belongs to the Convolvulaceae .Sweet potato is among the world's most important and under-exploited crop (Srivastava *et al.*(2012). Sweet-potato (*Ipomoea batatas* L) is the seventh most important food crop in the world. It is grown in many tropical and subtropical regions. Among the world's major food crops, sweet-potato produces the highest amount of edible energy/ha/day (Singh *et al.* 2008). Sweet-potato flour can serve as a source of energy and nutrients (carbohydrates, beta-carotene (pro-vitamin A), minerals (Ca, P, Fe, and K), and can add natural sweetness, color, flavor, and dietary fiber to processed food products. Because of the distinct properties, the use of sweet-potato flour in the preparation of bread is restricted; Biscuits are baked dry products, usually with a golden brown crust and crispy texture (Adegunwa *et al.* 2010)

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Whey was previously considered as waste because of its potential for spoilage. Now days however it is no longer considered as a waste product but treasure of nutritionally rich whey proteins. WPC has many health benefits and clinical importance. WPC is useful in the treatment of various diseases and health problems such as cancer and high cholesterol (St-Onge & Farnworth, 2000). It is effective in trauma, burn and renal failure (Peng *et al.* 2005; Miladinov *et al.*, 2006). It has the ability to act as antibacterial and antiviral agent (Tanaka *et al.* 1999). Whey proteins are easily and readily digested and therefore useful in post operative care of patients. Its use is beneficial in diabetes, cardiac ailment, liver problem, arthritis, gout and antihypertensive. It is antitumor agent and giving antioxidant effect (Eric *et al.* 2003; Keri, 2004). WPC has immune-enhancing property due to which it can be used in treating HIV patients. Whey protein also acts as a sport, food as whey proteins helps in speedy repairing of injured and torn muscle during practice and performance (Agin *et al.*, 2001; Hoffiman and Falvo, 2004). Whey proteins provide excellent nutritional values in nutrition, foods formulated for infant, kids, adults and old aged people as growth tonic for body health maintenance.

Bakery industry in India is considered as one of the major food processing industry with an annual demand of over 2758 MT (Ministry of Food Processing Industries, 2013). India is known to be the second largest manufacturer of biscuits, first being USA. Bakery products are the most popular food consumed by all age groups and are gaining popularity as processed foods because of their availability, ready to eat convenience, and comparatively good shelf life.

As discussed above, it is clear that sweet potato flour is rich in dietary fiber, functional fiber. Whey protein concentrate is rich in available protein content, high calcium and minerals, it can be considered as fortification for plain cookies.

Material and methods:

Sweet potatoes were procured locally from the field after harvesting. Roots were washed, trimmed and cured to make them free from soil and other foreign materials, rotting, insect damage and washed with common salt and made into slices, dried by using a tray drier at 60°C for 6h and then Grinding, Sieving on 70 mesh (Singh *et al.* 2008). The prepared Sweet potato flour Packed in HDPE and stored for 6 months or more in sealed containers.

WPC were procured from Mahan proteins ltd., Delhi, India. Refined wheat flour, sugar, shortening (Amul Butter) were procured from local market of Allahabad (India) and kept at room temperature for further use. All chemicals used were of analytical grade.

Preparation dough for cookies

The dough was made in a laboratory mixer. Fat and sugar was creamed in a mixer with a flat beater for 2 min at slow speed. Sodium chloride was added to the resulting cream, and mixed for 5 min at high speed to obtain a homogeneous mixture. Finally, flour containing various proportions of sweet potato flour, and whey protein concentrate (WPC-80), which had been sieved twice with baking powder was added, and mixed for 3 min at medium speed. The dough preparation, sheeting and moulding followed by different heat treatments like baking at 180°C for 15 mins, microwave heating at 180°C for 10 mins and frying at 180°C 8 mins. Combination treatment with different heat treatments is given in the following Table1.

HEAT TREATMENTS	TREATMENT COMBINATIONS	WHEAT FLOUR	SWEET POTATO FLOUR	WHEY PROTEIN CONCENTRATE (WPC-80)
Baking at 180°C for 15 mins.	T₀ HT₁	100	-	-
	T₁ HT₁	60	40	-
	T₂ HT₁	60	30	10
	T₃ HT₁	60	20	20
	T₄ HT₁	60	10	30
	T₅ HT₁	60	-	40
Microwave heating at 180°C for 10 mins.	T₀ HT₂	100	-	-
	T₁ HT₂	60	40	-
	T₂ HT₂	60	30	10
	T₃ HT₂	60	20	20
	T₄ HT₂	60	10	30
	T₅ HT₂	60	-	40
Frying at 180°C 8 mins.	T₀ HT₃	100	-	-
	T₁ HT₃	60	40	-
	T₂ HT₃	60	30	10
	T₃ HT₃	60	20	20
	T₄ HT₃	60	10	30
	T₅ HT₃	60	-	40

TABLE :1 Treatment Combination Of Different Cookies

Sensory evaluation

The evaluation was done by 5 trained and semi trained panelists at Warner College of Dairy Technology, SHUATS. Judgments for developed cookies were made through rating products on a 5 point Hedonic scale (Ranganna, 1986) with corresponding descriptive terms ranging from 5 ‘like extremely’ to 1 ‘dislike extremely’ having different quality attributes

such as colour and appearance , body and texture ,flavor and taste, mouth feel and over-all acceptability.

Microbial Analysis

Standard plate count, Yeast and mould and Coli form were determined by using serial dilution pour plate method. The number of colonies appeared on dilution plates were counted, averaged and reported as cells per gram (cfu/gm) of the sample.

Statistical analysis

To determine the statistical significance of sensory and microbial evaluation of cookies were analyzed using minitab18 software by ANOVA followed by Tukey's test (one-way) at a 5% significance level. All values are expressed as mean and standard deviation of five parallel measurements.

Results and discussion:

Organoleptic evaluation offers the opportunity to obtain a complete analysis of various properties of food as perceived by human senses. Sensory evaluation is an important and best method for evaluating the organoleptic properties of various products which provide quality measure and production control. To select the sensory attractive cookies prepared by different combinations of sweet potato and whey protein concentrate (WPC-80), were subjected to sensory evaluation using 5 point hedonic scale. Colour and appearance , body and texture ,flavor and taste, mouth feel and over all acceptability were the parameters studied for selecting the better product among the different treatment combinations. Organoleptic evaluation of developed cookies was carried out by a panel of 5 semi trained panel members and best product was selected based on the results from the score card. The results of various quality attributes are present in the **Table 2.1, 2.2, 2.3** and **Fig 1**.

The results of sensory evaluation of cookies indicated that among the different treatment combinations, T₁HT₃ (4.900± 0.224) was better acceptable in terms of colour and appearance. T₀ HT₃ (4.600±0.548) for flavour & taste, T₃ HT₁ (4.700±0.274) for body and texture, T₃ HT₁ (4.500±0.500) for mouth feel and T₃ HT₁ (4.800±0.274) for over- all acceptability

The sensory evaluations for three heat treatments were good in taste. The body and texture, consistency of fried cookies were reported to be too soft because of porous structure

developed during frying process, heat is transferred from hot oil to the product surface by convection and from the surface to the centre by conduction. The liquid water moves from inside of the fries to the evaporation zone leaving the product from the surface as vapour. Some of this vapour though, may remain trapped within the pores due to restrictive intercellular diffusion. The vapour in this confined space will expand and become superheated, distorting the pore walls and contributing to total porosity (Kawas & Moreira, 2001a; Moreira et al., 1995).

Sensory Properties of different types of cookies

TABLE: 2.1 Sensory Properties of Baked Cookies

Treatments combinations	Colour and appearance of cookies	Flavour and taste	Body and texture of cookies	Mouth Feel	Over All Acceptability
T₀HT₁	3.600±0.894 ^{ab}	3.400±0.548 ^{a,b}	3.000±0.000 ^c	3.600±0.548 ^{a,b}	3.200±0.447 ^c
T₁HT₁	4.600±0.548 ^a	4.200±0.447 ^a	4.400±0.548 ^a	4.400±0.548 ^{a,b}	4.600±0.548 ^{a,b}
T₂HT₁	3.400±0.548 ^b	3.600±0.548 ^{a,b}	3.400±0.548 ^{b,c}	3.400±0.548 ^b	3.600±0.548 ^{b,c}
T₃HT₁	4.600±0.224 ^a	4.200±0.447 ^a	4.700±0.274 ^a	4.500±0.500a	4.800±0.274 ^a
T₄HT₁	3.200±0.447 ^b	2.700±0.447 ^b	2.900±0.742 ^c	3.400±0.548 ^b	3.300±0.671 ^c
T₅HT₁	4.200±0.274 ^{ab}	4.100±0.742 ^a	4.100±0.548 ^{a,b}	4.100±0.548 ^{a,b}	4.100±0.548 ^{a,b,c}

Values are means±standard deviation from five parallel observations

Same letters within the same column do not differ significantly ($p < 0.05$) according to Tukey's test.

TABLE: 2.2 Sensory Properties of Microwaved Cookies

Treatments combinations	Colour and appearance of cookies	Flavour and taste	Body and texture of cookies	Mouth Feel	Over All Acceptability
T₀HT₂	3.600±0.548 ^{c,d}	3.200±0.447b	3.600±0.548 ^a	4.000±0.000a,b	4.000±0.000 ^{a,b}
T₁HT₂	4.500±0.354 ^a	3.300±0.274b	4.000±0.612 ^a	4.000±0.612a,b	4.400±0.224 ^a
T₂HT₂	4.200±0.274 ^{a,b,c}	3.600±0.548a,b	3.900±0.224 ^a	4.100±0.224a,b	4.200±0.274 ^{a,b}
T₃HT₂	4.400±0.548 ^{a,b}	4.400±0.548a	4.100±0.548 ^a	4.400±0.548a	4.300±0.447 ^a
T₄HT₂	3.700±0.274 ^{b,c,d}	3.700±0.447a,b	3.500±0.500 ^a	3.600±0.418a,b	3.700±0.274 ^b
T₅HT₂	3.000±0.000 ^d	3.100±0.224b	2.400±0.418 ^b	3.400±0.418b	2.700±0.274 ^c

Values are means±standard deviation from five parallel observations

Same letters within the same column do not differ significantly ($p < 0.05$) according to Tukey's test.

TABLE: 2.3 Sensory Properties of Fried Cookies

Treatments combinations	Colour and appearance of cookies	Flavour and taste	Body and texture of cookies	Mouth Feel	Over All Acceptability
T₀HT₃	4.400±0.548 ^{a,b}	4.600±0.548 ^a	4.200±0.837 ^{a,b}	4.400±0.548 ^a	4.600±0.548 ^a
T₁HT₃	4.900±0.224 ^a	3.200±0.274 ^b	4.400±0.418 ^{a,b}	3.600±0.418 ^{a,b}	4.400±0.418 ^a
T₂HT₃	3.900±0.742 ^{a,b,c}	3.900±0.742 ^{a,b}	4.600±0.548 ^a	4.200±0.447 ^a	4.200±0.837 ^a
T₃HT₃	3.300±0.274 ^{c,d}	3.700±0.447 ^{a,b}	4.000±0.000 ^{a,b}	3.600±0.418 ^{a,b}	3.700±0.274 ^{a,b}
T₄HT₃	3.800±0.837 ^{b,c,d}	3.600±0.894 ^{a,b}	3.300±0.975 ^{b,c}	3.600±0.894 ^{a,b}	3.700±0.837 ^{a,b}
T₅HT₃	2.800±0.274 ^d	2.800±0.447 ^b	2.400±0.418 ^c	3.000±0.000 ^b	2.900±0.224 ^b

Values are means±standard deviation from five parallel observations

Same letters within the same column do not differ significantly ($p < 0.05$) according to Tukey's test.

As the sweet potato flour concentration increased, the softness is decreased. It was reported in baking and microwave heat treatments were almost same but crust is for in baked cookies. One of the most important changes is the product evolving from semi-viscous dough to a solid alveolar structure at the end of baking. Air bubbles, introduced during the mixing of ingredients expand within the product during baking and contribute also to the volume expansion although to a lesser extent. Finally, upon baking the water evaporation/condensation within the product structure results in a significant moisture loss qualified as moderate drying. Another important reaction influencing the quality of baked product is the appropriate brown color development on the surface by sugar caramelization, Maillard reactions, starch dextrination and/roasting of protein network (Marcotte 2007). Where as in micro wave heating process avoids the problem of crust formation and surface browning. In contrast to conventional baking microwave heating inactivates this enzyme fast enough (due to a fast and uniform temperature rise in the whole product) to prevent the starch from extensive breakdown, and develops sufficient CO₂ and steam to produce a highly porous (Decareau, 1986).

Crispness is more in 40% sweet potato flour incorporated cookies (T₃ HT₁, T₃ HT₂) as per the sensory evaluation. The overall acceptability of the cookies was almost similar in baking and microwave heat treatments.

Sensory evaluation of developed cookies

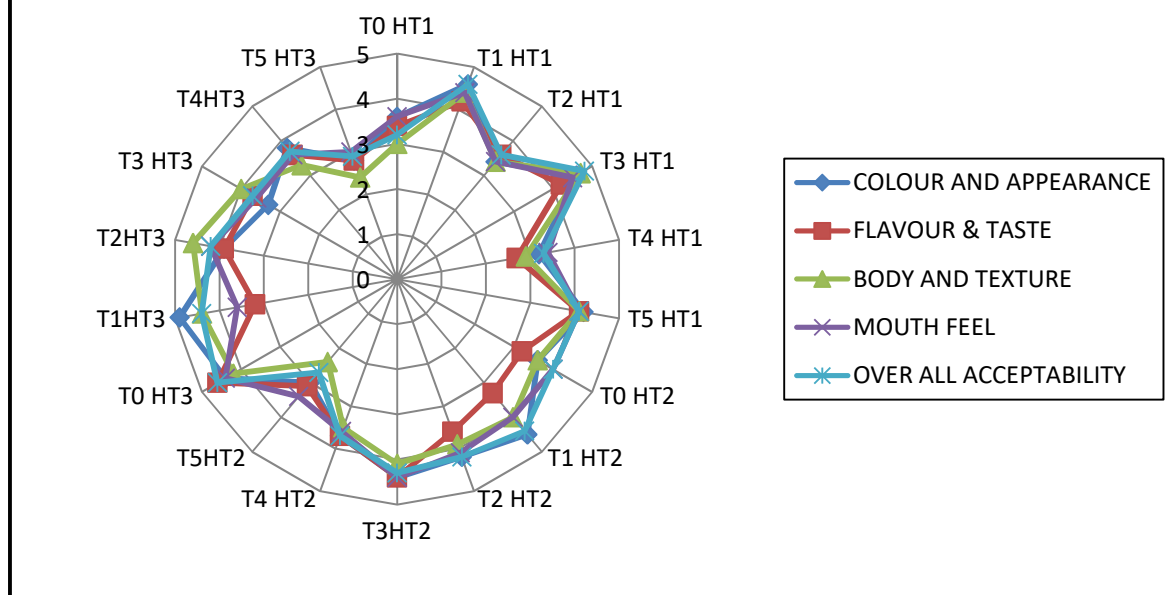


FIG: 1 Sensory evaluation of developed cookies

Microbiological assay

The obtained results for standard plate count (SPC), Yeast and mould and Coli forms in developed cookies are presented in **TABLE 3.1, 3.2 and 3.3**

On 0th day the SPC for baked cookies was more in T₅ HT₁ (3.600 ± 0.894) which was recorded in 40% whey protein concentrate (WPC-80), incorporated cookies and least in T₂ HT₁ as the days increased standard plate count (SPC) gradually increased. Yeast and mould count was recorded nil in 0th and 15th where as on 30th T₅ HT₁ was recorded as 0.200 ± 0.00 where as in Coli forms was highest on 30th day in T₁ HT₁ (2.800 ± 0.447) and the least was recorded on 0th day (Nil).

In microwave treated cookies SPC is high in T₁HT₂ (2.200 ± 0.837) and T₃HT₂ (2.200 ± 0.837) and least in T₂ HT₂ (1.400 ± 0.548) in on 0th day. Yeast and mould count was recorded nil in 0th and 15th where as on 30th T₅ HT₅ was recorded as 0.25 ± 0.434 . Coli is nil on 0th day and 15th day it is recorded in T₅HT₂ (1.520 ± 0.449). On 30th day coli form was recorded more which is highest in T₃HT₂ (2.360 ± 0.590) and least in T₄ HT₂ (1.360 ± 0.498)

Microbiological assay of different types of cookies

TABLE 3.1: Microbial Assay of Baked Cookies

Treatmet combinations	SPC(10^3) cfu/gm			Yeast and mould (10^3) cfu/gm			Coli forms(10^3) cfu/gm		
	0 th day	15 th day	30 th day	0 th day	15 th day	30 th day	0 th day	15 th day	30 th day
T₀ HT₁	1.800±0.844 ^b	2.600±0.894 ^{b,c}	3.200±0.837 ^b	Nil	Nil	Nil	Nil	Nil	1.400±0.548 ^b
T₁ HT₁	2.400±0.548 ^{a,b}	3.200±0.447 ^{a,b}	4.600±0.548 ^a	Nil	Nil	Nil	Nil	Nil	2.800±0.447 ^a
T₂ HT₁	1.400±0.548 ^b	1.800±0.447 ^c	2.200±0.837 ^b	Nil	Nil	Nil	Nil	Nil	1.800±0.837 ^{a,b}
T₃ HT₁	1.800±0.837 ^b	2.600±0.548 ^{b,c}	2.800±0.447 ^b	Nil	Nil	Nil	Nil	Nil	1.320±0.460 ^b
T₄ HT₁	2.200±0.447 ^b	2.600±0.548 ^{b,c}	3.200±0.447 ^b	Nil	Nil	Nil	Nil	Nil	1.800±0.447 ^{a,b}
T₅ HT₁	3.600±0.894 ^a	4.200±0.447 ^a	4.600±0.548 ^a	Nil	Nil	0.200±0.00 ^a	Nil	1.480±0.449 ^a	1.920±0.1789 ^{a,b}

Values are means±standard deviation from five parallel observations

Same letters within the same column do not differ significantly (p < 0.05) according to Tukey's test.

TABLE 3.2:Microbial Assay of Microwaved Cookies

Treatment combinations	SPC(10^3) cfu/gm			Yeast and mould (cfu/gm)			Coli forms(10^3) cfu/gm		
	0 th day	15 th day	30 th day	0 th day	15 th day	30 th day	0 th day	15 th day	30 th day
T₀ HT₂	2.000±0.707 ^b	3.000±0.707 ^b	4.000±0.7071 ^{a,b}	Nil	Nil	Nil	Nil	Nil	1.480±0.502 ^a
T₁ HT₂	2.200±0.837 ^b	2.800±0.447 ^b	3.800±0.8367 ^{a,b}	Nil	Nil	Nil	Nil	Nil	1.880±0.522 ^a
T₂ HT₂	1.400±0.548 ^b	1.800±0.447 ^c	2.200±0.4472 ^c	Nil	Nil	Nil	Nil	Nil	1.760±0.434 ^a
T₃ HT₂	2.200±0.837 ^b	3.200±0.447 ^b	3.400±0.5477 ^{b,c}	Nil	Nil	Nil	Nil	Nil	2.360±0.590 ^a
T₄ HT₂	2.800±0.447 ^{a,b}	3.00±0.0000 ^b	3.800±1.0954 ^{a,b}	Nil	Nil	Nil	Nil	Nil	1.360±0.498 ^a
T₅ HT₂	4.200±0.8370 ^a	4.600±0.548 ^a	5.200±0.4472 ^a	Nil	Nil	0.250±0.434 ^a	Nil	1.520±0.449 ^a	1.560±0.518 ^a

Values are means±standard deviation from five parallel observations

Same letters within the same column do not differ significantly (p < 0.05) according to Tukey's test.

TABLE 3.3:Microbial Assay of Fried Cookies

Treatment combinations	SPC(10^3) cfu/gm			Yeast and mould cfu/gm			Coli forms(10^3) cfu/gm		
	0 th day	15 th day	30 th day	0 th day	15 th day	30 th day	0 th day	15 th day	30 th day
T₀ HT₃	2.200±0.837 ^{b,c}	3.200±0.447 ^{b,c}	4.600±0.548a,b	Nil	Nil	Nil	Nil	Nil	1.520±0.502 ^b
T₁ HT₃	2.000±0.707 ^{b,c}	2.600±0.548 ^{c,d}	3.400±0.548b,c	Nil	Nil	Nil	Nil	Nil	2.200±0.447 ^{a,b}
T₂ HT₃	1.600±0.548 ^c	2.200±0.447 ^d	2.600±0.548c	Nil	Nil	Nil	Nil	Nil	1.520±0.502 ^b
T₃ HT₃	2.400±0.548 ^{b,c}	3.800±0.447 ^b	4.200±0.447a,b	Nil	Nil	Nil	Nil	Nil	2.040±0.0894 ^{a,b}
T₄ HT₃	3.200±1.095 ^{a,b}	3.600±0.548 ^b	4.200±0.837a,b	Nil	Nil	Nil	Nil	0.80± 0.748 ^b	1.720±0.832 ^{a,b}
T₅ HT₃	4.400±0.548 ^a	4.800±0.447 ^a	5.400±0.894a	Nil	Nil	0.12±0.548 ^a	Nil	1.96±0.080 ^a	2.680±0.460 ^a

Values are means±standard deviation from five parallel observations

Same letters within the same column do not differ significantly (p < 0.05) according to Tukey's test.

In fried cookies SPC, Yeast and mould and Coli form is recorded high as compared to the baked and microwave treated cookies. SPC ranges from 1.600 ± 0.548 ($T_2 HT_3$) to 4.400 ± 0.548 ($T_5 HT_3$) on 0th day. SPC increased on 15 to 30th day. Yeast and mould recorded nil on 0th and 15th day where as on 30th it is recorded in $T_5 HT_3$ (0.1200 ± 0.548) coli form is more on 30th day as compared to 0th and 15th day. It was observed that the all the treatment combinations values are still within acceptable limit.

Conclusion

From the present study, it could concluded that the 20% SPF and 20% WPC ($T_3 HT_1$ and $T_3 HT_2$)-supplemented cookie samples were nutritionally rich as well as more sensory acceptable product with regardless of both baking and microwave heat treatments. Evaluation results revealed that 40% SPF ($T_1 HT_3$) are also good in taste. The standard plate Count, yeast and mould count and coli forms of cookie samples were found within the acceptable limits. Thus, the present our study concludes that the supplementation level of 20% SPF and 20% WPC ($T_3 HT_1$) results are acceptable in the sensory, textural and nutritional characteristics.

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