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Development and Evaluation of Culturally-Competent Cookies Supplemented with Locally Grown Crops in Uttarakhand

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ABSTRACT

Present study was aimed to develop and assess the acceptability of culturally-competent cookies based on locally grown crops for the vulnerable population of a disaster-prone Himalayan state Uttarakhand. The supplemented cookies were developed using a cereal-pulse-millet mix of wheat flour, black soybean or *Bhat* flour and ragi or *Madua* flour in the ratio of 60:20:20 and were found to be high in protein (18.58%), fat (20.09%), fibre (1.67%), ash (2.53%), lysine (585.2 mg), NDP Cal % (13.4%), calcium (97.2 mg), iron (4.9 mg) and zinc (0.88 mg). These were acceptable for 60 days in aluminum laminate pouches. A consumer acceptability trial to determine the acceptability of these cookies by the local population showed a significantly (pd"0.01) higher acceptability by all age groups. It was concluded that cookies were nutrient dense food which can be effectively targeted for meeting the nutritional needs of the disaster hit population and address the food insecurity issues that arise aftermath any emergency especially when the donated food conflicts with the cultural/religious beliefs of the affected region.

Keywords: Black soybean, Culturally-competent cookies, Disaster-prone, Food assistance, Nutritional, Ragi, Sensory, Storage

INTRODUCTION

According to UKSDMA (Uttarakhand State Disaster Management Authority), the Himalayan regions of India are geologically fragile and highly eco sensitive, therefore, prone to certain types of natural disasters. Also, the unwarranted changes in landscape and moving towards the embankment of rivers for unscientific development of buildings and other infrastructures have also contributed to the vulnerability of this region to hazards like flash floods, cloud bursts (NIDM, 2013). According to GHA, 2009 aftermath of any disaster, the food becomes the first ray of hope for people to survive. Therefore, food assistance becomes an indispensable component of humanitarian assistance. The nutrient density of the food is of particular importance because protein and mineral needs of evacuees escalate significantly. It is therefore, essential that the general food-aid rations provided during emergencies are adequate, meet the basic nutritional requirements and are distributed consistently and in adequate quantities and at the same time also meet the cultural beliefs associated with the food habits because food habits are a powerful symbol which human beings learn first but change with the greatest reluctance (WHO/ WFP/UNICEF, 2006). Black soybean or *Bhat* is widely cultivated in Uttarakhand as they are a rich source of protein and iron. Local people have also been using ragi to make chapattis or flatbread for a long time. So far, no attempt has been made to design the food basket of the people of this vulnerable region, with the cookies made with these two local crops which are high in protein, minerals and fibre. This study aimed to develop culturally competent cookies using locally grown crops along with whole wheat flour. The aim was extended to analyze the

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developed cookies for sensory, nutritional and storage parameters and then test it for consumer acceptability in the Pithoragarh district of Uttarakhand.

METHODOLOGY

Ingredients like whole wheat flour, butter, milk and sugar powder were procured from the local market of Punjab Agricultural University, Ludhiana. The locally grown crops like black soybean and ragi were procured from the Pithoragarh district of Uttarakhand. Culturally competent cookies were developed using different blends of wheat flour, ragi flour and black soybean flour along with butter, milk and sugar powder. The standardization of the different blends to develop cookies is given in Table 1.

The sensory evaluation of the developed products was carried out by a total of fifteen panelists including five semi-trained panelists from the faculty of Department of Food and Nutrition, Punjab Agricultural University with approximate age between 40 to 55 years and ten untrained panelists of the respective states residing in the Hostels of Punjab Agricultural University, Ludhiana. The local people of the Himalayan state, Uttarakhand were chosen due to their familiarity with the local crops of their state. The panel was provided 9-point hedonic scale to assess the attributes like appearance, colour, texture, aroma, taste and overall acceptability (Larmond, 1976). The proximate composition was conducted as per the standard AOAC (2000) methods. The total minerals (Ca, Fe and Zn) were estimated by Atomic Absorption Spectrophotometry. Lysine content was calculated by the method of Carpenter, 1960 as modified by Booth, 1971. The NDP Cal % was calculated by the method of Platt *et al*., 1961. Two packaging material Aluminum laminate (AL) and High-density polypropylene (HDPE) pouches were used to store the developed cookies. These packets were further stored in a plastic airtight container at ambient room temperature (30±2°C) for 60 days. The changes in moisture content, free fatty acids and peroxide value were recorded using standard AOAC (2000) procedures periodically after 0, 15, 30, 45 and 60 days. The developed cookies were also tested for sensory scores using a 9-point hedonic scale to study the changes in colour, appearance, texture, taste and overall acceptability of the cookies during storage (Figure 1).

Table 1: Standardization of the culturally competent cookies

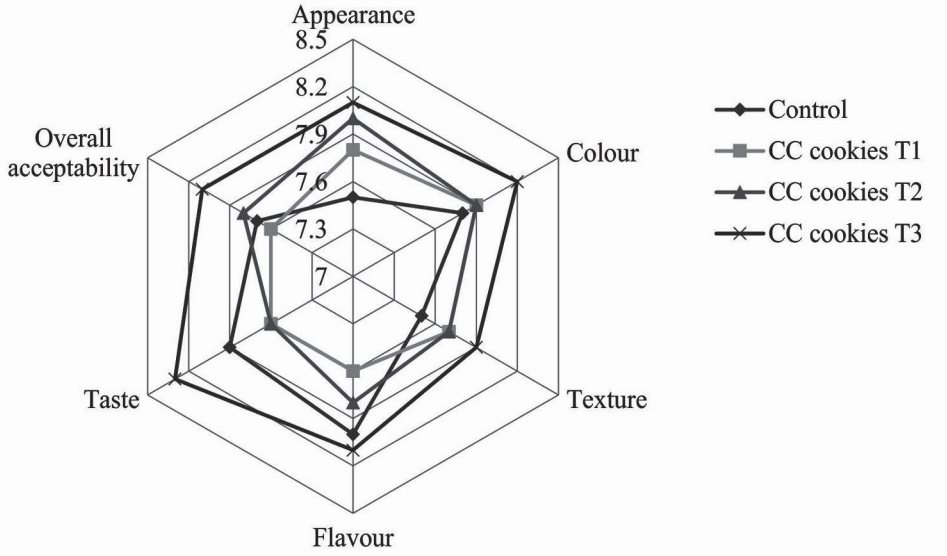
Ingredients	Control	T1	T2	T3
Refined Flour (g)	100	-	-	-
Whole wheat flour (g)	-	80	70	60
Blacksoy Flour (g)	-	10	15	20
Ragi Glour	-	10	15	20
Milk (ml)	20	20	20	20
Butter (g)	50	50	50	50
Baking powder (g)	2	2	2	2
Sugar Powder (g)	50	50	50	50

Pithoragarh district of Uttarakhand was selected to assess the consumer acceptability of the culturally competent cookies. A total of 40 subjects with a male: female ratio being 10:30 were selected covering all age groups. The research was approved by the ethical committee of Punjab Agricultural University, Ludhiana and informed written consent was obtained from the involved participants and they were explained in detail the study protocol. The acceptability of the cookies against control was determined by the local residents. The study used a 5 point continuum offering five options; dislike very much, dislike moderately, neither like nor dislike, like moderately, and like very much. To accommodate the respondents' limited reading and writing skills, each option was represented by a simple picture of a face, ranging from an unhappy expression for 'dislike very much' to a very happy expression for 'like very much'.

RESULTS AND DISCUSSION

The control cookies were prepared using refined wheat flour. In other three formulations, whole wheat flour, *ragi* flour and black soybean flour were used in the ratio of 80:10:10 (T1); 70:15:15 (T2) and 60:20:20 (T3), respectively. The scores for overall acceptability revealed that T3 was significantly (p*d"*0.05) more acceptable than T1 and T2, as well as control and this, could be attributed to the addition of black soybean flour and ragi flour. Some studies have shown that addition of 10 or 15% soy flour to wheat flour produced acceptable products such as bread or biscuits (Awasthi *et al*., 2012;

Figure 1: Sensory scores of culturally-competent cookies



Control : Refined wheat flour
Supplemented CC Cookies: Whole wheat flour: black soybean flour: ragi flour
T1-80:10:10; T2-70:15:15; T3: 60:20:20

Banureka and Mahendran, 2011; Farzana and Mohajan, 2015; Kumari *et al*., 2019).

The proximate composition of cookies presented in Table 2 shows that the protein content of the supplemented cookies was significantly ($p \leq 0.01$) higher as compared to the control cookies. The increase in protein content could be due to the soy fraction of the blended flour as the soy flour has higher protein (40.2%) as compared to wheat flour i.e. 12.1 per cent (Bassinello *et al*., 2011; Singh *et al*., 2020). The fat content of the supplemented cookies was also significantly ($p \leq 0.01$) higher as compared to control. The increment was due to the fact that the fat content of soy flour is higher in comparison to the wheat flour (Abioye *et al*., 2011). In addition, fat also imparts tenderness, moistness, lubricity, flavor, color and anti-staling qualities in baked products. In consistence with other studies, the crude fibre content in the cookies increased significantly as compared to the control (Ayo *et al*, 2014; Ndife *et al*., 2011). The culturally competent cookies had higher ash content in comparison to the control. In contrary to proximate principles, the calculated total carbohydrate value of the supplemented cookies was lower than the control. The findings were in line with several other studies (Awasthi *et al*., 2012; Mishra and Chandra, 2012; Giram *et al*., 2017). The energy content of the cookies was slightly decreased when compared to the control as a result of low carbohydrate value in the cookies. The results of the proximate composition indicated that the protein, fat, fibre and ash content of the culturally competent cookies effectively enhanced**.** Therefore, they can be used as a nutrient dense product during food assistance targeted

Table 2: Nutritional composition of the culturally competent cookies in comparison to control cookies

Nutrient	Control	Supplemented CC Cookies	t-value
Crude protein (g)	15.27±0.06	18.58±0.03	19.38**
Crude fat (g)	18.81±0.06	20.09±0.47	12.73**
Crude fiber (g)	1.15±0.03	1.67±0.02	22.75**
Ash (g)	1.86±0.03	2.53±0.05	27.28**
Carbohydrates (g)	61.11±0.05	54.15±0.35	33.36**
Energy (Kcal)	475±0.50	472±0.93	4.95*
Lysine(mg/100g)	413.3±5.64	585.2±4.62	40.80**
NDP Cal %	7.73	13.40	
Calcium (mg/100g)	43.9±0.06	97.2±1.57	58.67**
Iron (mg/100g)	3.2±0.07	4.9±0.04	34.4**
Zinc (mg/100g)	0.54±0.01	0.88±0.04	12.36**

Values are Mean±SD, * Significant at 5% level of significance; **Significant at 1% level of significance
Control : Refined wheat flour- 100%, Cookies: Whole wheat flour: black soybean flour: ragi flour - 60:20:20

towards meeting the increased nutrient needs of disaster-hit victims during disaster and rehabilitation phase.

The lysine content and NDP Cal % are important parameters of protein quality and their values for the supplemented cookies as shown in Table 2, revealed that the lysine content of the cookies was significantly ($p \leq 0.01$) higher as compared to the control. The quality of protein was improved in the cookies that were supplemented with black soybean and ragi flours. Presence of soybean flour in the composite flours impacted the amino acid composition of the biscuits where essential amino acids like lysine, tryptophan and arginine raised one to two folds (Sparvoli *et al*., 2016). It contains more lysine, threonine, methionine and valine than other millets. The NDP Cal %, the calorie contribution of protein in the diet is also an indicator of protein quality. When lysine was taken as limiting amino acid, a higher value of NDP Cal % was observed in the cookies as compared to the control. It could be attributed to the incorporation of black soybean and ragi in the cookies. The ideal NDP Cal to support growth is 8 per cent. The above-mentioned results showed that the supplemented cookies had an NDP Cal % higher than 8 per cent which is clear evidence that it can sufficiently support the growth of an individual normally as well as in emergency situations. Total minerals like calcium, iron and zinc of the supplemented cookies was significantly (pd"0.01) higher than the control. The higher content of these minerals may be attributed to the addition of ragi flour in the cookies. Ragi is exceptionally rich in calcium (344 mg %) and contains 283 mg % phosphorus and 3.9 mg % iron. Soybean was reported to be the common Asian legume as the richest source of protein, iron and calcium (Keatinge *et al*., 2011). The absorption of calcium and iron from soy is also reported to be high. It was suggested that ragi being the cheapest source of calcium, may be used to prepare common daily foodstuffs to increase their nutritional value, acceptability and palatability (Goswami *et al*., 2017).

The shelf life of the supplemented cookies was analyzed as a function of time and storage conditions in different packaging materials for parameters like moisture, free fatty acids (FFA), peroxide value (PV) and overall acceptability (Table 3). It was observed that HDPE packing showed an increased rate of moisture gain than AL pouches. The FFA of the cookies significantly ($p \leq 0.05$) increased when packed in AL and HDPE packets after 60 days of storage. Although, there was not much difference in the scores of cookies packed in AL and HDPE, however, higher values were recorded in those packed in HDPE, thus, making AL a better option for packaging. The PV of the cookies increased gradually as the storage period increased up to 60 days. There was no significant difference observed for overall acceptability of the cookies after 15, 30, 45 and 60 days of storage when packed in AL pouches. However, after 45 days, a significant ($p \leq 0.05$) decrease in acceptability of cookies was observed when HDPE packaging was done. The results revealed that AL pouches as packaging material provided better acceptability of the cookies. Similar findings were reported by Singh *et al.* (2020).

Table 3: Effect of time and packaging material on moisture, free fatty acids, peroxide value and overall acceptability of culturally competent cookies

Storage duration (days)	Moisture (%) Packaging material		Free Fatty Acids (%) Packaging material		Peroxide value ($meqO_2\ kg^{-1}$) Packaging material		Overall acceptability Packaging material	
	AL	HDPE	Al	HDPE	Al	HDPE	Al	HDPE
CC Cookies								
0	4.64±0.35^{a}	4.64±0.35^{a}	0.41±0.11^{a}	0.41±0.11^{a}	8.24±0.08^{a}	8.24±0.08^{a}	8.12±0.18^{a}	8.12±0.18^{a}
15	4.95±0.24^{b}	4.98±0.34^{b}	0.48±0.03^{b}	0.49±0.12^{b}	8.46±0.09^{b}	8.52±0.06^{b}	8.05±0.21^{a}	7.94±0.20^{a}
30	5.23±0.22^{c}	5.31±0.27^{c}	0.52±0.06^{c}	0.54±0.04^{c}	8.73±0.15^{c}	8.86±0.08^{c}	7.91±0.17^{a}	7.78±0.16^{a}
45	5.45±0.31^{d}	5.58±0.36^{d}	0.57±0.04^{d}	0.60±0.17^{d}	8.98±0.13^{d}	9.12±0.10^{d}	7.85±0.25^{a}	7.69±0.19^{a}
60	5.71±0.17^{e}	5.84±0.25^{e}	0.61±0.08^{e}	0.64±0.13^{e}	9.14±0.07^{e}	9.35±0.09^{e}	7.70±0.22^{a}	7.58±0.18^{b}

Al: Aluminum laminate pouches; HDPE: High density polypropylene, Values are Mean ± SD; Values in columns followed by different superscripts differ significantly ($p \leq 0.05$)

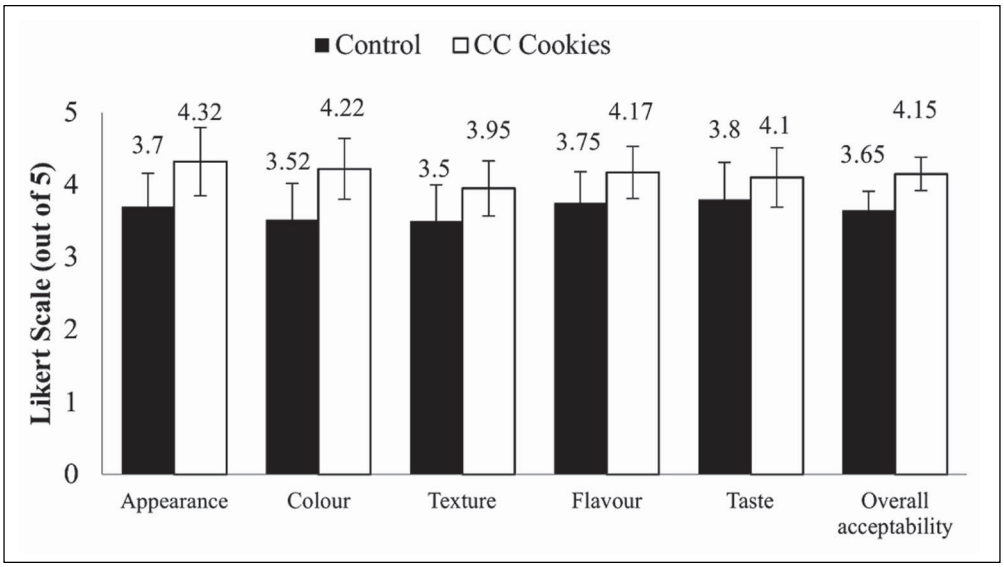


Figure 2: Consumer Acceptability of culturally competent cookies by local population of Pithoragarh district of Uttarakhand, India

The overall acceptability of the supplemented cookies by a group of 40 subjects from Pithoragarh district of Uttarakhand was significantly ($p \leq 0.01$) higher as compared to the control (Figure 2). The mean rating scores for the cookies indicated a range of 'liked moderately' to 'like very much'. The increase in acceptability could be attributed to the use of locally grown ingredients i.e. ragi flour and black soy flour. The local population found it very innovative to use their familiar legume and millet in the cookies.

CONCLUSION

In emergency situations, ready-to-eat meals such as high-energy/protein biscuits may serve a useful purpose. Therefore, the cookies made up of ragi and black soy flour could be used as an immediate response at the outset of the emergency when no other foods/cooking facilities are available. It addresses the food security component of humanitarian assistance and helps prevent the wastage of food due to unfamiliarity with food and sometimes due to cultural or religious conflicts with the donated relief foods. The developed cookies being nutrient dense can be effectively included in the food basket of disaster-hit victims. It can also be consumed widely by the general population of the Uttarakhand state even in non-emergency situations. It can also end up in the food baskets of beneficiaries of ICDS and mid-day meal program where children are provided high protein and energy-rich foods.

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