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# Development and evaluation of organoleptic and microbial quality of guar gum incorporated composite flour cookies

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**Abstract**
The present study is conducted to develop and evaluate the organoleptic and microbial quality of guar gum incorporated composite flour cookies. The standardization is important in order to select the best proportion or level of guar gum and composite flour for the preparation of cookies. Wheat flour was replaced with different proportion of horse gram and pearl millet flour. The ratio of composite flour as wheat flour: horse gram: pearl millet was for $T_0$ (100:0:0), $T_1$ 50:30:20 and 0.1% guar gum, $T_2$ 50:30:20 and 0.2% guar gum, $T_3$ 50:30:20 and 0.3% guar gum, $T_4$ 50:30:20 and 0.4% guar gum respectively. Sample $T_3$ (0.3% guar gum) was found to be organoleptically superior over other samples. Microbiological studies conducted for best cookies sample (0.3% guar gum) revealed that total plate count of these cookies was $0\times10^3$ to $4.1\times10^3$ and yeast & mould count of cookies was $0\times10^3$ to $2.4\times10^3$ during 0 to 90 days of storage. Cookies produced by 0.3% addition of guar gum, 20% pearl millet flour, 30% horse gram flour and 50% refined wheat flour was acceptable and their contamination level was still within acceptable limit.

**Keywords**: Pearl millet, Horsegram, Guar gum, Process standardization

## 1. Introduction
Millets are one of the oldest foods known to humans and possibly the first cereal grain to be used for domestic purposes. Millets are small-seeded grasses that are hardy and grow well in dry zones as rain-fed crops, under marginal conditions of soil fertility and moisture. Millets share a set of characteristics which make them unique amongst cereals. Millets grow under dry conditions, can cope with relatively poor soils and require few external inputs. Pearl Millet [*Pennisetum americanum* (L.) *Leeke*] is an important cereal, contributing to the calorie and protein requirements of people in the semi-arid tropics (SAT). It is grown mostly in regions of low rainfall and is capable of withstanding adverse agro climatic conditions. About 85% of the production is used for human consumption, particularly in the SAT regions of Africa and Asia They are a staple food with superior nutritional qualities compared to other cereals. India is the biggest producer of millets in the world and millets remain a staple crop for numerous households. When properly stored, whole millets will keep for two or more years. Baked products are foods mainly based on cereal flours which are blended with other ingredients. Millet protein lacks gluten, hence it is unsuitable as the sole material for preparation of bakery products. (Changmei and Dorothy, 2014) [8].
Legumes are good sources of cheap and widely available proteins for human consumption. They are staple foods for many people in different parts of the world. Legume seeds have an average of twice as much protein as cereals and the nutritive value of the proteins are usually high. Legumes seeds are of prime importance in human and animal nutrition due to their high protein content (20- 50%) and have historically been utilized mainly as the whole seeds. Recently, they are now being fractionated into their main constituents which are starch and protein. (Marimuthu and Krishnamoorthi, 2013) [16].
In India, horse gram is cultivated as a pulse crop contributing about 0.33% of the total food grain production. Reports on nutritive value of horse gram indicate it as an excellent source of protein (up to 25 %), carbohydrates (60%), essential amino acids, energy, and low content of lipid (0.58%), iron and molybdenum. Ant calcifying inhibitors of crystallization present in seed extract of horse gram are water soluble, heat stable, polar, non-tannin and non-protein in nature and hence, it is being used in treatment of kidney stones (Yasin *et al*., 2014) [19].
Cookies belong to the group of food products that are very popular in daily diet of almost all profiles of consumers, having not only the nutritive purpose but influencing also on emotional status of consumers with the effects even on the positive mood enhancement.

Cookies are characterized with quite long shelf life, which results in their availability almost everywhere at any time. Therefore, the alteration of composition of cookies directed to enhancement their nutritive and functional properties or to enabling of their consumption to the groups of consumers with special needs and demands has been the subject of interest of many researchers. The basic composition of cookies enables a variety of different possibilities for achievement of dietary properties of the products with respect to type, share and function of three main components for cookie dough production: flour, fat and sugar. There are different possibilities for development and production of dietary cookies, from sugar replacement or reduction, over alteration of fat shares, composition and properties to enrichment of cookies with different functional components (Popov-Raljic *et al.*, 2013) [17].

## Materials and Methods

### Raw Material

Raw material such as refined wheat flour, horse gram flour, and Pearl millet flour were purchased from the local market of Parbhani.

### Chemicals and Glasswares

The chemicals and glassware's used during the present investigation was taken from the Department of Food Chemistry and Nutrition, College of Food Technology, Parbhani.

### Equipments and Machineries

Equipments including weighing balance, hot air oven, muffle furnace and bakery oven were used from the Department of Food Chemistry and Nutrition and Food Science and Technology, College of Food Technology, VNMVK, Parbhani.

### Method

**Recipe for preparation of cookies:** The cookies were prepared using the basic recipe as follows:

**Table 1:** Recipe for control cookies preparation.

| Ingredient | Quantity (g) |
|---|---|
| Refined wheat flour | 100.0 |
| Sugar | 50.00 |
| Shortening | 50.0 |
| Baking powder | 1.5 |
| Ammonium bicarbonate | 1.5 |
| Milk | As per requirement |

To find out suitable level of guar gum for preparation of cookies, wheat flour was replaced with different proportion of horse gram and pearl millet flour. The ratio of composite flour as wheat flour: horse gram: pearl millet was for $T_0$ (100:0:0), $T_1$ 50:30:20 and 0.1%guar gum,$T_2$ 50:30:20 and 0.2% guar gum, $T_3$ 50:30:20 and 0.3% guar gum, $T_4$ 50:30:20 and 0.4%guar gum respectively.

### Preparation of guar gum incorporated cookies

Shortening and powdered sugar were creamed. The dry ingredients i.e. refined wheat flour, sodium bicarbonate, ammonium bicarbonate etc. were mixed together. The dry mix and homogenous paste of sugar and shortening was mixed thoroughly. It was thoroughly kneaded manually by adding required amount of water. The dough prepared was rolled in a uniform shape and of 6 mm thickness and cut into round shape cookies with the help of cutter. These cookies were baked at 175$^0$C for 15 min in oven (Dhankhar, 2013) [11].

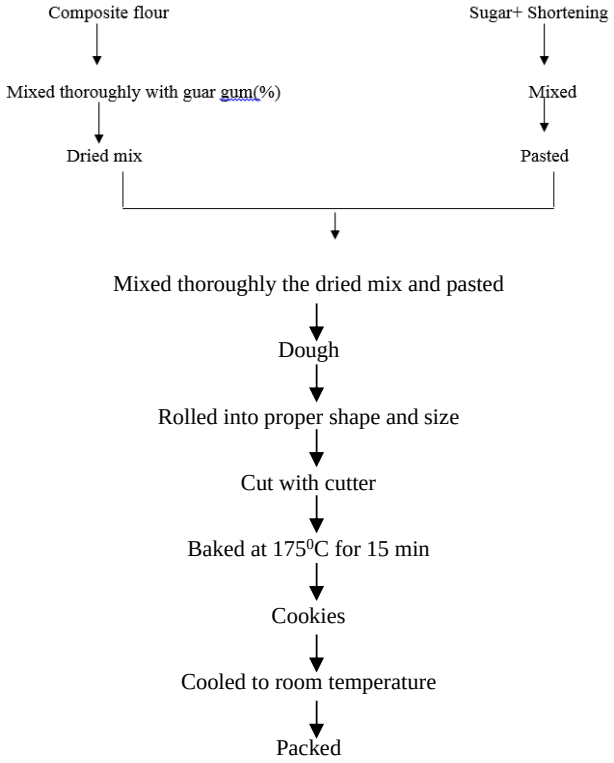


**Fig. 1:** Flow sheet for preparation of cookies

### Proximate composition analysis

The proximate composition (moisture, fat, protein, ash, fiber) of samples were determined using standard procedures (AACC, 2000) [1]. Carbohydrate content was determined by difference method.

### Sensory evaluation

The cookies were evaluated for sensory attributes by a panel of 10 semi-trained judges, using a 9 point Hedonic scale system for different parameters like colour and appearance, thickness, size, shape, flavour, texture and grain, crispiness and overall acceptability. The mean values of 10 semi-trained judges were considered for evaluating the quality (Avasthi, 2012) [4].

### Microbial examination of composite flour cookies

Microbial examination is the perfect quality assessment protocol performed in food products quality analysis. In the study of microbial quality Total Plate Count (TPC), Yeast and Mold were examined for that following procedures were adopted.

### Total Plate Count (TPC)

The total plate count of cookies was determined by using Nutrient Agar containing. The dilutions were made up to $10^{-4}$ and the 0.1 ml of aliquot was used for the isolation. All process was carried out in a strictly sterile area with the help of Laminar Air Flow. Plates were incubated at 37$^0$ C for 48 hrs and results noted in CFU/ml. Total Plate Count (TPC) of cookies was examined on 1, 2 and 3 months period (Chandru *et al.* 2010) [7].

### Yeast and Mould

The Yeast and Mould count of cookies was determined by using Potato Dextrose Agar (PDA) and the streak plate technique was used for the isolation. The media was sterilized and poured into plates. The dilutions of sample were made up

to $10^{-4}$ and then 0.1 ml of aliquot was used for streaking. Plates were incubated at $37^0$ C for 48 hrs, and results noted in CFU/ml.

**Statistical analysis**

The data obtained was analyzed statistically to determine statistical significance of treatments. Completely Randomized Design (CRD) was used to test the significance of results (Panse and Sukhatme, 1967).

## Results and Discussion

**Table 2:** Proximate composition of horse gram, pearl millet and refined wheat flour

| Samples | Moisture (%) | Fat (%) | Protein (%) | Ash (%) | Crude fiber (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|
| Horse gram | 9.80 | 1.30 | 21.25 | 2.71 | 5.40 | 59.54 |
| Pearl millet | 9.10 | 5.09 | 11.41 | 2.62 | 1.50 | 70.28 |
| Refined wheat flour | 11.05 | 1.64 | 11.85 | 1.62 | 0.89 | 72.77 |
| SE+ | 0.1209 | 0.0089 | 0.106 | 0.0097 | 0.0299 | 0.0022 |
| CD at 5% | 0.3640 | 0.0268 | 0.319 | 0.0292 | 0.1233 | 0.0067 |

* Each value is a mean of three determinations.

The data presented in Table 2 revealed that the highest moisture content was noticed in refined wheat flour (11.05%) followed by horse gram (9.80%) whereas the lowest moisture content was observed in pearl millet (9.10%).. It was observed that the fat content of pearl millet was 5.09% whereas fat content of refined wheat flour was 1.64% whereas lowest fat content was observed in horse gram (1.30%). Highest Ash content was observed in horse gram (2.71%) followed by pearl millet (2.62%) whereas lowest ash content was noticed refined wheat flour (1.62%).

The data revealed that higher protein content was observed in horse gram (21.25%) and pearl millet (11.41%) whereas lowest protein content was observed in refined wheat flour (11.85%). Highest crude fiber content was recorded in horse gram (5.40%) followed by pearl millet (1.50%) whereas lowest crude fiber was recorded in refined wheat flour (0.89%). Highest Carbohydrate content was observed in refined wheat flour (72.77%) followed by pearl millet (70.28%) whereas lowest carbohydrate content was observed in horse gram (59.54%). Results are in line with those reported by Singh *et al.,* (2012), Kumaravel and Natarajan (2015).

**Table 3:** Chemical composition of composite flours cookies incorporated with guar gum

| Sample | Moisture (%) | Fat (%) | Protein (%) | Carbohydrate (%) | Ash (%) | Crude fiber (%) |
|---|---|---|---|---|---|---|
| $T_0$ | 3.25 | 21.22 | 6.81 | 67.08 | 1.22 | 0.42 |
| $T_1$ | 3.89 | 22.61 | 14.87 | 54.04 | 2.23 | 2.36 |
| $T_2$ | 4.14 | 22.69 | 15.09 | 53.22 | 2.42 | 2.44 |
| $T_3$ | 4.32 | 22.74 | 15.28 | 52.65 | 2.50 | 2.51 |
| $T_4$ | 4.51 | 22.81 | 15.42 | 52.02 | 2.61 | 2.63 |
| SE+ | 0.006 | 0.006 | 0.007 | 0.0042 | 0.004 | 0.01 |
| CD at 5% | 0.019 | 0.018 | 0.021 | 0.0126 | 0.013 | 0.029 |

*Each value is a mean of three determinations.

The data revealed that the moisture content in the cookies increased slightly with added hydrocolloids than the control sample. This might be due to water binding capacity of gum. This property of hydrocolloids has been attributed to the hydroxyl groups in the hydrocolloid structure which allows more water interactions through hydrogen bonding (Friend *et al*., 1993). It could be observed that fat content increased progressively with the increasing levels of guar gum. Highest fat content (22.81%) was recorded in treatment $T_4$ whereas lowest fat was recorded in treatment $T_0$ (21.22%). It can be observed that protein content gradually increased with increasing levels of guar gum in cookies .The highest protein was observed in treatment $T_4$ (15.42%) where lowest protein was recorded in treatment $T_0$ (6.81%). Increase in protein content might be due to the higher protein content in horse gram and pearl millet flour. When these protein rich sources are added to biscuits they add protein to it. The data about crude fiber indicated that crude fiber gradually increased with increasing levels of guar gum. Highest crude fiber was recorded in treatment $T_4$ (2.63%), while lowest fiber was found in $T_0$ (0.42%). Results are in close agreements with those reported by Amin *et al.,* 2016) [3].

Ash (1.22 to 2.61%) was observed as the gum increases as compare to control. Highest ash was recorded in treatment $T_4$ (2.61%) followed by $T_3$ (2.50%), $T_2$ (2.42%) and $T_1$ (2.23%). This might be due to the addition horse gram and pearl millet flour. Similar results were observed by Yousaf *et al.* (2013) who reported that the addition of gram flour resulted in an increase in ash content of cookies. It could be observed that carbohydrate content was gradually decreased with increasing levels of guar gum in cookies (Table 6). Highest carbohydrate was observed in treatment $T_0$ (67.08%) whereas lowest carbohydrate was observed in $T_4$ (52.02%). Decrease in carbohydrate might be due to the incorporation of hydrocolloids and Increase in fat content of cookies. The results are in agreement with Gambus *et al.,* (2007) [13].

**Table 4:** Sensory evaluation of composite flour cookies incorporated with guar gum

| Treatment | Color and Appearance | Texture | Taste | Flavor | Overall Acceptability |
|---|---|---|---|---|---|
| $T_0$ | 8.4 | 8.4 | 8.3 | 8.0 | 8.1 |
| $T_1$ | 8.1 | 7.5 | 7.9 | 7.7 | 7.7 |
| $T_2$ | 7.7 | 7.2 | 8.0 | 7.9 | 7.6 |
| $T_3$ | 7.5 | 7.4 | 8.5 | 8.4 | 8.0 |
| $T_4$ | 7.2 | 6.5 | 7.7 | 7.5 | 7.2 |
| SE+ | 0.06055 | 0.07638 | 0.05 | 0.05477 | 0.0639 |
| CD at 5% | 0.18228 | 0.22992 | 0.1505 | 0.16488 | 0.19236 |

*Each value is a mean of three determinations.

Data presented in Table 4 revealed that there were a significant effect of pearl millet flour and horse gram flour on color and appearance of cookies. Highest score was recorded for $T_0$ (8.4) followed by $T_1$ (8.1), $T_2$ (7.7), $T_3$ (7.5). Lowest

score was recorded in $T_4$ (7.2) in which 0.4% guar gum were used respectively to prepare cookies. Ganorkar and Jain (2014) [14] reported the same result after supplementing full fat flaxseed flour with wheat flour to prepare cookies.

It could be observed thatscores for texture of cookies were significantly decreased with increasing levels of guar gum. Highest score (8.4) was recorded for $T_0$ while lowest score (6.5) was recorded for $T_4$. The decrease in texture score of cookies might be due to the higher protein content present in flours which resulted in poor entrapment of air during dough mixing and made the cookies harder. Aziah *et al.*, (2012) found that texture of cookies become hard with incorporation of protein rich legume flour.

Highest score for taste of cookies was observed in treatment $T_3$ (8.5) where lowest score was observed in treatment $T_4$ (7.7). Highest score for flavour was recorded for treatment $T_3$ (8.4) where lowest score was recorded for treatment $T_4$ (7.5). It was observed that the taste and flavour of cookies were in acceptable range up to 30% incorporation of horse gram flour. Beyond these, more dominating taste and flavour were observed.

It could be observed that all the treatments were in acceptable range. Highest score for overall acceptability of cookies were observed in treatment $T_3$ (8.0) which are at par with $T_0$ where lowest score was recorded for treatment $T_4$ (7.2).

**Table 5:** Microbial analysis of guar gum Incorporated composite flours cookies

| Storage Period | Total plate count (cfu/g)$10^3$ | Yeast and Mould (cfu/g)$10^3$ |
|---|---|---|
| 0 | 0 | 0 |
| 30 | 1.2 | 1 |
| 60 | 2.1 | 1.7 |
| 90 | 4.1 | 2.4 |

*Each value is the average of three determinations

Total viable counts were used as a measure of microbiological quality with respect to the levels of the general microbial contamination. Microbiological studies conducted for best cookies sample (0.3% guar gum) revealed that total plate count of these cookies was $0\times10^3$ to $4.1\times10^3$ and yeast &mould count of cookies was $0\times10^3$ to $2.4\times10^3$ during 0 to 90 days of storage. Agu and Ndidiamaka (2014) [2] reported that the growth observed could be due to post processing contamination .These findings showed that cookies produced by 0.3% addition of guar gum,20% pearl millet flour,30% horse gram flour and 50% refined wheat flour was acceptable and their contamination level was still within acceptable limit. This may be due incorporation of guar gum and dry nature of the cookies. These results are similar with the results obtained by (Banusha and Vasantharuba 2014, Chopra *et al.*, 2014) [6, 9].

## Conclusion

The data obtained in present investigation are enough to draw conclusion that horse gram, pearl millet is effective substitute for refined wheat flour for bakery products. The cookies prepared by using horse gram, pearl millet with incorporation of guar gum were found to be acceptable in quality characteristics. This substitution of horse gram and pearl millet for refined wheat flour of the cookies increased the protein content.The cookies prepared with the replacement of 30% horse gram, 20% pearl millet, 0.3% guar gum were found to be most acceptable with good microbial quality.

Hence, it is finally concluded that developed processing technology for preparation of guar gum incorporated composite flour cookies is techno-economically feasible. Cookies with this formulation should be made and marketed on large scale to provide nutritious, healthy food products to consumers.

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