

Preparation and Nutritional Quality of Sorghum *Shankarpali*

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ABSTRACT

The present study was undertaken with the objectives to develop protocol for preparation of sorghum *Shankarpali*, to study the organoleptic properties of sorghum *Shankarpali*, identify the superior genotype of sorghum for *Shankarpali* preparation, and to study the nutritional quality parameter of sorghum grains as well as its *Shankarpali*. Five varieties and two hybrids were used for preparation of sorghum *Shankarpali*. The experiments were laid in completely randomized design with seven treatments and three to ten replications. The crude protein content in grain and *Shankarpali* ranged from 13.64 to 18.28 per cent and 9.4 to 11.15 per cent, respectively. The variety M 35-1 gave numerically higher level of protein. The Total sugar content in grain ranged from 1.62 to 1.95 per cent and in *Shankarpali* ranged from 33.30 to 34.25 per cent. Phule Anuradha showed higher level of total sugar in grain and *Shankarpali* than the other genotype. The crude fiber content in grain and *Shankarpali* ranged from 2.70 to 3.25 and 2.80 to 4.35 per cent respectively. The fat content in grain and *Shankarpali* ranged from 1.25 to 1.66 per cent and 26.95 to 33.73 per cent, respectively. The ash content in sorghum grain and *Shankarpali* ranged from 4.01 to 4.45 and 1.30 to 1.58 per cent respectively. Preliminary study with various combinations (0 to 100 % sorghum flour addition) was conducted and 50 % addition of sorghum flour for the preparation of *Shankarpali* was found most suitable. Then five varieties and two hybrids with 50% combination for *Shankarpali* were judged for genotype identification. The organoleptic properties of *Shankarpali* prepared from sorghum flour were judged on the basis of colour, appearance, texture, flavour, taste and overall acceptability of the product by semi-trained judges on 9 point hedonic scale. The products prepared from Sorghum flour i.e. *Shankarpali* was liked very much and gave highest rating of more than 8. While considering the yield of *Shankarpali* from sorghum grains as well as their nutritional composition and organoleptic properties of the niche products prepared from them, the variety, Phule Revati was the best one as compared to the other varieties and hybrids.

Key words: Sorghum, *Shankarpali*, nutritional value, organoleptic value of *Shankarpali*

INTRODUCTION

Sorghum (*Sorghum bicolor* L.) is one of the major cereal crop consumed in India after rice (*Oryza sativa* L.) and wheat (*Triticum aestivum* L.). Sorghum is commonly called as jowar or great millet. The crop is primarily produced in Maharashtra and Southern states like Karnataka and Andhra Pradesh. These three states are together account for close to 80 per cent of all India production.

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Madhya Pradesh, Gujarat and Rajasthan are the other states producing sorghum. India is the third largest producer of sorghum in the world with 5.54 million tons in 2013-14 and almost entire production of sorghum (95 per cent) in the country comes from above regions¹. Millets sorghum and pulses are traditionally the staple grains for household consumption². In rural areas of central Maharashtra, per capita annual consumption of sorghum is around 70 kg, accounting for almost half of per capita consumption of all cereals³. Sorghum is considered as coarse grain due to presence of outer fibrous bran of the seed. About 700 million people are nourished by sorghum, since it constitutes a source of calories, protein and minerals. Progress has been made in developing high yielding varieties and hybrids with improved agronomic traits that resulted in excess production. Nutritional importance of sorghum is 349 Kcal energy, 10.4 g protein, 1.9 g fat, 72.6 g carbohydrates, 25 mg calcium, 4.1 mg iron, 0.37 mg thiamine, 0.13 mg riboflavin per 100 g of grain^{4,5,6,7}.

Sorghum protein is superior to wheat protein in biological value and digestibility. Sorghum is totally free from gluten contain more fiber and micronutrients. As sorghum digested slowly is an excellent health food for people suffering from diabetes in India⁸. Starch is major carbohydrate in the grain. The other present are simple sugar, cellulose and hemicelluloses. The amylose content of starch varies from 21 to 28%. Starch from waxy varieties contain little amylose. Both waxy and regular starches contain free sugar upto 1 to 2 %. Sucrose being major constituent (0.85 %) followed by glucose (0.09 %), fructose (0.09 %) and maltose⁹. The Percentage of different protein fractions to the total protein of sorghum grown in India is albumin 5; globulin 6.3; prolamin 46.4 and glutelin 30.4 per cent. Prolamins and Glutelin are principally present in the endosperm. Amino acid analysis of various protein fractions shows that there is better distribution of all essential amino acids in globulins than in prolamins. A vegetarian diet based on some varieties of sorghum is somewhat better than rice based diet. In the last two decades the nature and composition of utilization of sorghum grain has undergone a change from staple food to industrial uses as livestock and poultry feed, potable alcohol, starch and ethanol production¹⁰. Processed food products for human consumption are emerging such as *chakali*, *shankarpali*, *papads*, *sweets*, *edile* etc^{11,12}. Many sorghum varieties and hybrids are developed in India to increase yield and for processing of sorghum e.g. Wani, Gulbhendi, and Dagdi varieties are used for *Hurda* (roasted grains) purpose and SPV-84 for syrup and jaggery¹³. Sorghum will continue to be major food crop in several countries, especially in Africa and in particular in Nigeria and The Sudan, which together account for about 63 % of Africa's sorghum production. These grains are used for traditional as well as novel foods. However, there is a need to look into the possibilities of alternative uses. Though, sorghum and millets have good potential for industrial uses, they have to compete with wheat rice and maize. Sorghum could be in great demand in the future if the technology for specific industrial end uses is developed.

The use of sorghum in common foods such as *idali* (a steamed product), *dosa* (a leavened product) can be popularized for wider use in sorghum-growing areas¹⁴. A few important sun-dried or extruded and sun-dried products from sorghum are *papad*, *badi* and *kurdigai* sold in the market. These products usually have a shelf-life of over one year. They can be popularized through marketing channels similar to those used for rice products. Incentives should be provided to food industry to use sorghum for novel processed food products like snacks, bread, biscuits, *flakes*, *papad*, *rava* etc. and traditional processed products¹⁵. A number of different processes are used in the preparation of ready-to-eat cereals, including flaking, puffing, and shredding and granule formation in wheat, corn and rice¹⁶. Improved processing methods for flaking have to be developed for the better utilization of the increased grain sorghum production. The grain characteristics required to produce traditional food products of high quality have been reported^{17,18}. *Shankarpali* is popular in Diwali festival products and at present they are mostly made from maida. By suitable processing it might be feasible to produce *Shankarpali* from sorghum. Ready to eat products like *Shankarpali* is very popular being crispy, sweet and friable in texture. The relatively smaller size and quick hydration of millets make them most suitable for the production of *Shankarpali*. The technology for preparation of *Shankarpali* from sorghum and their nutritional values information are not available. Therefore the present study was undertaken to develop protocol for preparation of *Shankarpali*, to study the organoleptic properties of *Shankarpali* and identify the best sorghum genotype for preparation of *Shankarpali*.

MATERIALS AND METHODS

The grains of five sorghum varieties *viz.*, Phule Anuradha, Phule Vasudha, Phule Revati, CSV-22, M35-1 and two hybrids, CSH-15-R, SPH-1620 were obtained from the All India Co-ordinated Sorghum Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri. Other ingredient such maida, sugar salt etc., purchased from local grocery shop. The various chemicals used were of the analytical grade, procured from M/s. Sarabhai M. Chemicals, M/s. Baroda, E. Merck (India) and M/s. Qualigen's or S.d. Fine Chemical Ltd., Mumbai.

Cleaned sorghum grains were subjected to milling in laboratory by grinding mill. Whole sorghum flour was used for preparation of *Shankarpali*. Chemical analysis of sorghum grains for protein, total sugar, crude fiber, fat and ash were done using NIR Spectrometer, Spectra Analyzer serial No: 05; 281, ZEUTEK Opto Elektronik GmbH, Keiler str. 211, 24768 Rendsburg, Germany. Chemical analysis of sorghum *Shankarpali* for protein, crude fiber, ash and fat was done using standard methods¹⁹ and total sugar determined by the method of Nelson²⁰.

Preparation of *Shankarpali*: *Shankarpali* was prepared using sorghum flour and maida combination as a ratio (sorghum flour : Maida): T₁ = 00:100, T₂ = 10:90, T₃ = 20:80, T₄ = 30:70, T₅ = 40:60, T₆ = 50:50, T₇ = 60:40, T₈ = 70:30, T₉ = 80:20, T₁₀ = 90:10 and T₁₁ = 100:00.

Flour prepared from sorghum varieties and wheat maida (NIAW-301, Trimbak) was utilized for the preparation of *Shankarpali*. For the preliminary trials Maldandi (M 35-1) variety of sorghum was utilized for the identification of the best combination for the preparation of *Shankarpali*. The best identified combination was utilized for the preparation of *Shankarpali* from other sorghum genotypes.

Recipe for preparation of sorghum *Shankarpali*: Sorghum flour 100g, maida 100g, sugar 100g salt 3g, baking powder 1g and ammonium bicarbonate 2g, cardamom powder 5g, water 50ml and oil for deep frying 100ml.

Procedure

First sorghum flour was taken and then added maida, sugar, and other ingredients and with the help of water dough was prepared then pressed round and cut into squares with knife and fried in deep fat frying then cooled and stored for further study. Ammonium bicarbonate is used for release of carbon- dioxide from product and increasing puffiness and crispiness. The *Shankarpali* can be prepared upto 90 percent sorghum flour. For varietal identification the nutritional and organoleptic properties were considered and 50:50 ratio of sorghum : maida was finalized.

Organoleptic evaluation of *Shankarpali*: The organoleptic evaluation of *Shankarpali* for colour and appearance, texture, flavor, taste and overall acceptability was carried out using standard method of Amerine²¹ for this ten semi trained judges were used and 1 to 9 point Hedonic Scale was used for rating the quality of the sorghum product.

Statistical analysis: All chemical constituents and organoleptic parameter were analyzed by using 3 and 10 replications respectively. The data obtained in the present investigation was statistically analyzed by using Completely Randomized Design given by Panse and Sukhatme²².

RESULT AND DISCUSSION

In the present investigation procedure was standardized for the preparation of *Shankarpali*. The most promising sorghum genotypes also tried to identify for the *Shankarpali* production. The nutritional quality and niche product development and their consumer acceptance also judged by using semi trained judges and 1 to 9 point Hedonic Scale.

Nutritional composition of sorghum grain: The crude protein content in grain ranged from 8.25 to 10.45 per cent. The variety M 35-1 gave significantly higher level of protein (10.45 %) in the grain and followed by CSV-22 (10.40 %), Phule Vasudha (10.15 %) and Phule Revati (9.45 %; **Table 1**). FAO²³ and Beta²⁴ was observed content of the protein in whole sorghum grain range of 7 to 15 per cent. Robertson²⁵ reported that crude protein in experiment sorghum ranged from 9.14 to 13.00 per cent. Chavan⁶ observed protein content in sorghum ranged from 9.6 to 14 per cent.

The total sugar content in grain ranged from 1.62 to 1.95 per cent. The variety Phule Anuradha gave significantly higher level of total sugar (1.95 %) in the grain and followed by Phule Revati (1.94 %), CSV-22 (1.94 %) and M35-1 (1.85 %). Ibrahim²⁶ recorded total soluble sugar content from 0.54 to 3.38 per cent, from 0.54 to 4.89 per cent and from 0.41 to 4.41 per cent in *Hamra*, *Shahla* and *Baida* sorghum varieties.

The fiber content in grain ranged from 2.70-3.25 per cent the hybrid CSV-22 gave significantly higher level of fiber (3.25 %) in the grain and followed by Phule Anuradha (3.20 %), M35-1 (2.90 %) and Phule Vasudha (2.85 %). Ratnavathi²⁷ reported crude fiber among the thirteen cultivars varied from 1.57 per cent (M35-1) to 2.4 (SPV-462). Vannalli²⁸ revealed that proximate composition of sorghum grain for crude fiber ranged from 2.47 per cent. Chavan⁷ reported crude fiber content ranged from 1.90 to 2.64 per cent.

The fat content in grain ranged from 1.25 to 1.75 per cent. The variety Phule Vasudha gave significantly higher level of fat (1.75 %) in the grain and followed by M35-1 and SPH-1620 (1.65 %). The fat content in grain sorghum ranges from 2.1 to 7.6 per cent²⁹. Kazanas and Fields³⁰ reported that fat content increase non-significantly in sorghum meal due to fermentation treatment. The ash content in grain ranged from 4.01 to 4.45 per cent. The variety Phule Revati gave significantly higher level of ash (4.45 %) in the grain and followed by Phule Vasudha (4.40 %) and CSV-22 (4.30 %).

Organoleptic evaluation of *shankarpali* prepared from different combination of sorghum + maida:

The results of organoleptic evaluation of *Shankarpali* prepared from maida with combination of sorghum flour at different ratio are presented in **Figure 1**. For the preparation of *Shankarpali* various combination of maida + sorghum flour used to find out the best combination.

In preliminary studies Maida and sorghum flour 10 to 100 ratios was used but only upto 90 parts of sorghum flour gave good *Shankarpali*. Hundred per cent sorghum flour *shankarpali* was not good quality therefore this treatment was discarded.

Colour and appearance score for *shankarpali* ranged from 5.04 to 7.84. Control sample gave highest score (7.84) for colour and appearance followed by combination of Maida and sorghum flour i.e. 60:40 (7.54) and 90:10 (7.52) ratios. Statistically these combinations are at par. Flavour score for *shankarpali* ranged from 6.51 to 8.17. Combination of Maida and sorghum flour i.e. 60:40 gave highest score (8.17) for Flavour followed by 50:50 (8.13) and 90:10 (7.53) ratios. Statistically 60:40 and 50:50 ratios are at par. Crispiness score for *shankarpali* ranged from 5.41 to 8.28. Combination of Maida and sorghum flour i.e. 60:40 gave highest score (8.28) for crispiness followed by 50:50 (8.25) and control (8.12) ratios. Statistically they are at par. Taste score for *shankarpali* ranged from 5.21 to 8.34. Combination of Maida and sorghum flour i.e. 50:50 gave highest score (8.57) for Taste followed by Control (8.06) and 80:20 (7.86) ratios. Overall acceptability score is based on the average score of colour and appearance, flavour, crispiness and taste of the food product. While considering the all parameters of *shankarpali* prepared from addition of sorghum flour to maida it gives excellent acceptability. Overall acceptability was considering colour and appearance, flavour, crispiness and taste for *shankarpali* ranged from 5.87 to 7.93. Combination of Maida and sorghum flour i.e. 50:50 (7.93) had highest overall acceptability followed by 60:40 (7.88) and control (7.76) ratios.

The variation in the organoleptic scores at different ratios occur due to nutrients inter related reactions and development of various reaction product which are giving different colour, flavour, crispiness and taste. The combination of these all parameters decides the food acceptability by the consumer. Sorghum having several nutritional health benefits for human. Therefore these benefits can be get by addition of sorghum flour in maida while preparation of *shankarpali* and use as a niche product in human diet. Mostly fiber, minerals and phytochemicals such as phenolics and tannins which acts as antioxidants can be get through the *shankarpali* food product.

Organoleptic evaluation of *shankarpali* prepared from different genotype of sorghum flour + maida: Colour and appearance score for *shankarpali* ranged from 7.21 to 8.24 (**Figure 2 and Plate 1**). The variety Phule Revati gave highest score (8.24) for colour and appearance followed by M35-1 (8.13) and Phule Vasudha (7.83). Flavour score for *Shankarpali* ranged from 7.42 to 8.06.

The variety M35-1 (8.06) gave highest score for flavour followed by SPH-1620 (7.84) and Phule Anuradha (7.82). These are the statistically at par. Flavour is also very sensitive parameter for acceptance for the food product. If the food product is giving pleasant flavour consumer accept that food product without any hesitation. Flavour is mostly depends on the frying oil quality for specially fried *Shankarpali* as well as some chemical reactions occur during frying. Crispiness score for *shankarpali* ranged from 7.06 to 8.64. Phule Revati gave highest score (8.64) for crispiness followed by M35-1 (8.25) and Phule Vasudha (8.04). Taste of food product is sensation perceived by the taste buds and influenced by the texture, flavour, taste and composition of product. It is one of the essential parameter related to acceptability of the food product. Taste score for *shankarpali* ranged from 7.21 to 8.57. The variety Phule Revati gave highest score (8.57) for taste followed by M35-1 (8.12) and Phule Vasudha (8.05). Overall acceptability for *shankarpali* ranged from 7.40 to 8.30. The variety Phule Revati had highest overall acceptability score (8.30) followed by M35-1 (8.14) and control (8.08).

Sorghum varieties have their own specific characteristics for food product development and their organoleptic parameters due to various nutritional components variations. While preparation of niche product such as *shankarpali* and their frying they develop specific flavour, texture/crispiness and taste to the product. Therefore, they are giving variations in the organoleptic parameters. Considering the nutritional composition and organoleptic properties Phule Revati was found best among the other genotypes used in this study for the preparation niche food product such as *shankarpali* upto 50 % incorporation with Maida.

Chemical composition of *shankarpali* prepared using Maida + sorghum flour:

Crude Protein: Protein content in *shankarpali* ranged from 9.4 to 10.32 % (**Figure 3**). The variety Phule Vasudha gave highest protein content (11.15 %) followed by M35-1 (11.10 %) and Phule Anuradha (10.32 %). Chavan¹¹ reported the protein contain 6.50 % in *shankarpali* prepared from sorghum flour and maida in 1:2 proportion.

Total Sugar: Total sugar content in *shankarpali* ranged from 33.3 to 34.25 %. The variety Phule Anuradha gave highest total sugar content (34.25 %) followed by Phule Revati (34.17 %) and CSV-22 (34.15 %). These are statistically at par.

Fat Content: Fat content in *shankarpali* ranged from 26.95 to 33.73 %. The variety Phule Vasudha gave highest fat content (31.69 %) followed by CSV-22 (30.72 %) and Phule Anuradha (30.22 %). But it was lowest in Phule Revati i.e. 26.95 per cent. This indicated that *shankarpali* prepared using Maida and sorghum flour of Phule Revati absorbs less oil during frying which is good for health as well as shelf life of the food product. Chavan¹¹ reported the fat contain 22.3 % in *shankarpali* prepared from sorghum flour and Maida in 1:2 proportion.

Crude fiber: Crude fiber content in *shankarpali* ranged from 2.80 to 4.35 %. The variety CSV-22 gave highest crude fibre content (4.35 %) followed by Phule Anuradha (4.25 %) and M35-1 (4.24 %). Chavan¹¹ reported the crude fiber contain 1.40 % in *shankarpali* prepared from sorghum flour and maida in 1:2 proportion.

Ash Content: Ash content in *shankarpali* ranged from 1.3 to 1.58 %. The hybrid CSH-15-R gave highest ash content (1.58 %) followed by Phule Vasudha (1.38 %) and Phule Anuradha (1.36 %). Five sorghum varieties and two hybrids were used in this study. The niche product *shankarpali* was prepared using Maida and different sorghum genotypes flour in the proportional of 50:50. The nutritional composition of the *shankarpali* varied due to the variation in the sorghum genotypes nutrient content. While considering the overall nutritional composition and organoleptic properties Phule Revati was found most suitable for the preparation of *shankarpali*. Another advantage of this genotype is that it absorbs less oil while frying the *shankarpali* which is positive point of the niche food product.

Economics of *Shankarpali*: The cost of *Shankarpali* was calculated as per existing prices at the time of the study. The cost of production of *Shankarpali* was 87/kg (**Table 2**). This cost did not include rent, transport charges, sale commission and local taxes etc.

Table 1: Nutritional composition of sorghum grain and maida

Name of genotype	Protein (%)	Total sugar (%)	Crude fiber (%)	Ash (%)	Fat (%)
Phule Anuradha	9.15	1.95	3.20	4.30	1.30
Phule Vasudha	10.15	1.65	2.85	4.40	1.75
Phule Revati	9.45	1.94	2.75	4.45	1.25
CSV-22	10.40	1.94	3.25	4.35	1.35
M35-1	10.45	1.85	2.90	4.30	1.65
CSH-15-R	8.71	1.72	2.82	4.08	1.55
SPH-1620	8.25	1.75	2.70	4.01	1.65
Maida	11.5	2.5	1.9	1.7	1.9
Range	8.25-10.45	1.62-1.95	2.70-3.25	4.01-4.45	1.25-1.75
Mean	9.50	1.82	2.92	4.26	1.5
SE ±	0.027	0.028	0.028	0.028	0.028
CD at 5%	0.083	0.087	0.088	0.090	0.087
CV%	0.500	2.73	1.707	1.172	0.121

Three replications mean values.

Table 2: Economics of shankarpali making

Item	Rate (Rs/kg)	Quantity (g)	Cost (Rs.)
Raw material			
Sorghum	20	500	10.00
Maida	40	500	20
Sugar	36	500	18
Oil	80	500	40
Salt, baking powder, Ammonium bicarbonate, cardamom powder)	-	-	20
Labour charges	30	-	30
Fuel and packaging misscellaneous	-	-	20
Total yield (kg)	-	1.8 kg	158.00
Cost/kg (<i>Shankarpali</i>)	-	-	87.00

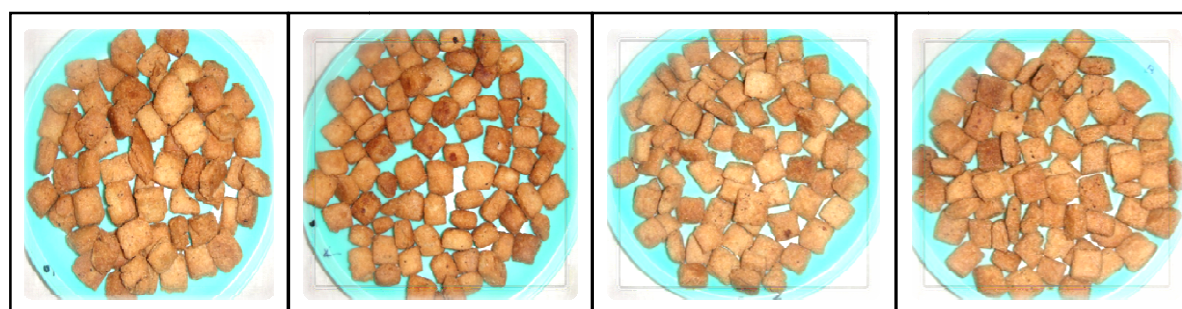


Control

Phule Anuradha

Phule Vasudha

Phule Revati



CSV-22

M-35-1

CSH-15-R

SPH-1620

Plate 1: Shankarpali prepared from different genotype of sorghum (maida:sorghum flour, 50:50, w/w)

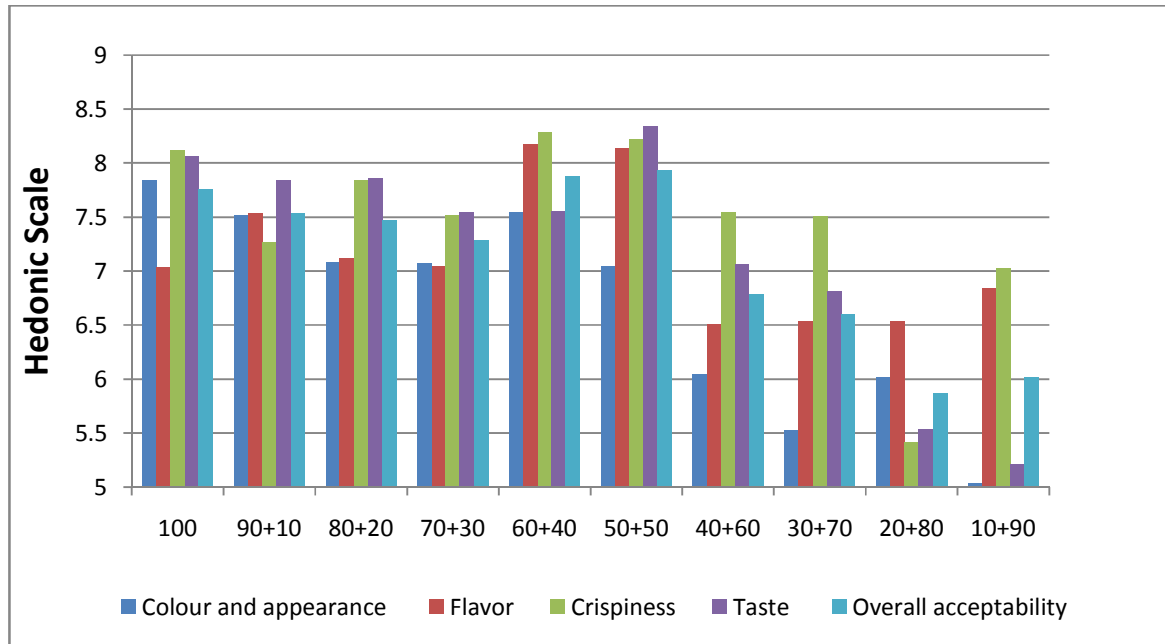


Fig. 1: Organoleptic evaluation of *Shankarpali* prepared from different combination of sorghum flour and maida

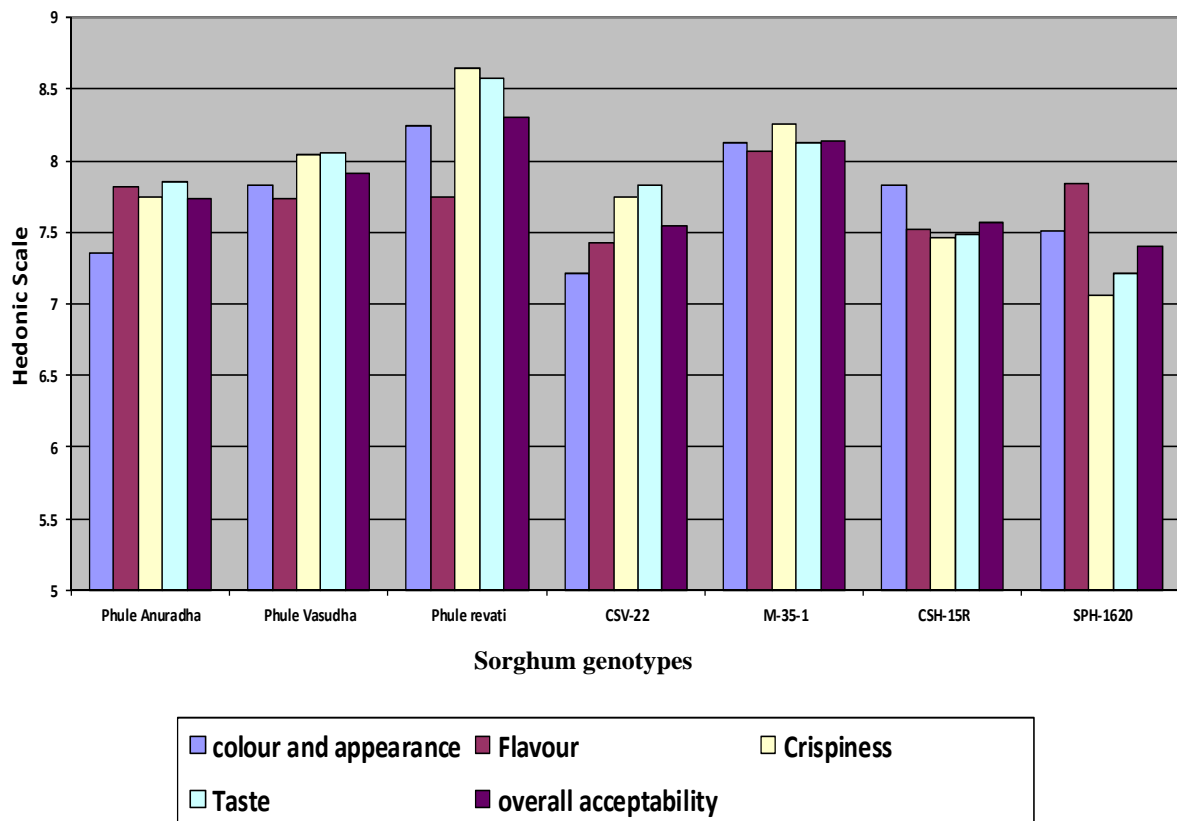


Fig. 2: Organoleptic evaluation of *Shankarpali* prepared from different genotype of sorghum flour and maida

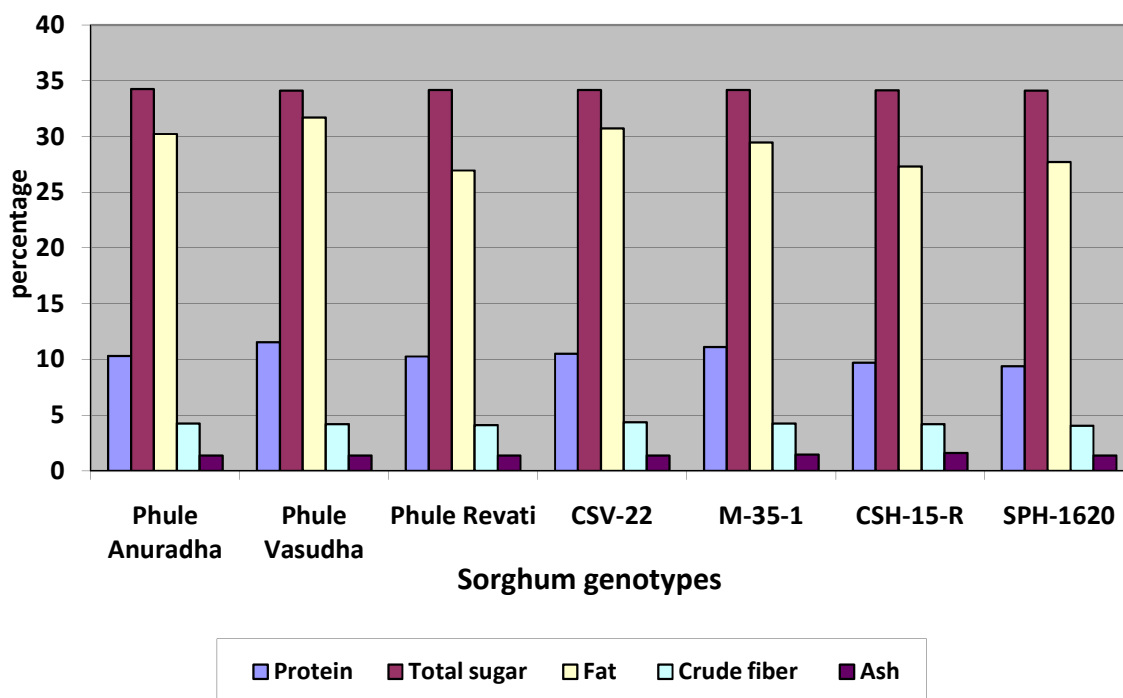


Fig. 3: Chemical composition of *Shankarpali* (maida + sorghum flour)

CONCLUSION

While considering the yield of *Shankarpali* from sorghum grains as well as their nutritional composition and organoleptic properties the variety, Phule Revati at 50:50, w/w ratio of Maida and sorghum flour was the best one as compared to the other varieties and hybrids.

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