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Original Research Article

Development and Quality Evaluation of Sorghum and Soybean Incorporated Value Added *Sev*

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A B S T R A C T

The present study was undertaken to develop and assess the quality of sorghum and soybean incorporated value added *Sev*. It was found that the *sev* developed from sorghum and soybean incorporated into wheat (WH-1129) flour possessed highest total soluble sugars and non-reducing sugars i.e. 4.64 and 5.25%, respectively, while control *sev* had highest reducing sugars and starch content of 0.68 and 58.49%, respectively. Similarly control *sev* developed from wheat flour (100%) exhibited higher *in vitro* starch and protein digestibility of 45.44 mg maltose released/g meal and 71.03%, respectively compared to that developed from WH-1129 and HD-2967 wheat varieties. The *sev* developed from sorghum and soybean flour incorporated into WH-1129 wheat flour had highest phytic acid 281.07 mg/100g, while HD-2967 composite flour *sev* exhibited significantly ($P<0.05$) higher contents of polyphenol. The shelf life study was done to know the market potential of the value added *sev*. For shelf life studies, *sev* were stored in air tight container at room temperature (15-30˚C) and analyzed for fat acidity and peroxide value. Fat acidity of value added *sev* were significantly higher than control *sev* and increased during storage period (90 days), however increase was within the acceptable limit. The peroxide value was not detected in control and value added *sev* up to three months of storage, which indicated that no rancidity developed in all types of *sev* during storage. Thus, sorghum and soybean incorporated nutritionally superior *sev co*uld be developed and have prospects of being beneficial for vulnerable population and can be taken up as an entrepreneurial activity by farm women.

Keywords

Incorporated, S*ev*, Value added, *In vitro* digestibility, Fat acidity, Peroxide value

Introduction

Traditional snacks are the largest category in the Indian savory snacks market. '*Sev'* is deep fat fried snack which is popular throughout the country (Pruthi *et al.*, 1983, Kumar *et al.*, 2019). Traditionally, it is prepared from Bengal gram/chickpea flour (Besan) with addition of salt and spices. Some additives are added to give crisp and crunchy texture to the fried snacks. (Kumar *et al.*, 2019). India has a big market for savory snacks which grew at a CAGR (Compound Annual Growth Rate) of 29.04% during the period 2010–2015 and has expected CAGR of 33.59% during the period 2015–2020. The market value is expected to reach INR 1,410,936.0 million by 2020 (MoFPI, 2017).

Sorghum species (*Sorghum vulgare* and *Sorghum bicolor*) are members of the grass family. Sorghum forms the staple diet of a majority of the populations living in the semi-arid tropics of Africa and India. Sorghum is known by different names throughout world like matama in East Africa, great millet and guinea corn in West Africa, kafir corn in South Africa, dura in Sudan, jowar in India and kaoliang in China (Kulamarva, 2009). Sorghum is a gluten-free cereal and plays significant role to cure Celiac Disease in the present day scenario. Sorghum contains various phenolic and antioxidant compounds that possess health benefits to inhibit tumor formation and make the grain suitable for developing functional foods and other applications. Sorghum, like other cereals, is an excellent source of starch and protein. The starches and sugars in sorghum are released more slowly than in other cereals (Klopfenstein, 1995, Kumar *et al.,* 2019) and hence it could be beneficial to diabetics. Due to its nutritional significance and its easy adaptability to a wide range of growing conditions and lesser water requirements, sorghum has potential to be incorporated in the diets of human around the world, specifically to those intolerant to wheat.

Soybean (*Glycine max*) is identified as 'Miracle bean' for its health related benefits and high nutrient content. Soybean is widely grown in the central part of India where the bulk is utilized for producing oil or for animal feed and its usage for human or direct consumption is increasing steadily (Singh, 2016, Kaur and Kaur, 2019). It is known for its nutritional attributes *viz*. high protein and fat content and can substantially serve as a cost-effective food for improvement of daily diets of people and has immense potential in the reduction of protein-energy malnutrition (Goel *et al.,* 2018, Kaur and Kaur, 2019). It contains good amount of essential macro nutrients for regulating good nutrition i.e. carbohydrate 18%, protein 40% and fat 20%, fiber 10% and moisture 9% with other micro nutrients 5% consisting of calcium, potassium, iron and folate (Singh, 2009).

Soybean contains phytochemicals namely iso-flavones which helps in reduction of cholesterol thus reducing heart diseases and regulation of menopause (Mishra and Chandra, 2012). The regular consumption of soybean prevents certain diseases namely diabetes, atherosclerosis and cancer (Mohammadi *et al.,* 2015). The supplementation of sorghum and soybean flour with other cereal based savoury products give the complete and overall essential amino acid balance and can help to get rid of the protein calorie malnutrition in the world.

Keeping in view the tremendous value of sorghum and soybean, the present study was undertaken to incorporate sorghum and soybean flour in '*sev'*, not only to diversify utilization of sorghum and soybean but also to bring value addition and improve nutritional value of 'sev', the present study was conducted to develop and to assess the quality of sorghum and soybean incorporated *sev*.

Materials and Methods

Procurement of raw material

Seeds of wheat (*Triticum aestivum*, WH-1129, HD-2967 and C-306), and (Sorghum vulgare, HJ-541) used were procured in a single lot from the breeders, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar. Soybean (*Glycine max*) flour along with other ingredients required for the development of value added *sev* were purchased from the local market of Hisar.

The wheat and sorghum grains were ground in an electric grinder (Cyclotec, M/s Tecator, Hoganas, Sweden) and flours thus obtained were sieved through a 60 mesh sieve and packed in airtight plastic containers for further analysis.

Development of Sorghum and soybean incorporated *sev*

Ingredients

Supplementation level (%)	Wheat flour (g)	Sorghu m flour (g)	Soybean flour (g)	Salt (g)	*Ajwain* (g)	Red chilli powder (g)	Turmeric powder (g)	Garam masala (g)	Oil
Control (100%WF)	100	-	-	4	2	4	2	2	For frying
WF : SGF : SBF 60 : 30 : 10	60	30	10	4	2	4	2	2	For frying
40 : 40 : 20	40	40	20	4	2	4	2	2	For frying

Quality evaluation of sorghum and soybean incorporated sev

Total soluble sugars other than the starch were extracted according to the procedure of Cerning and Guilbot (1973).

Twenty five ml ethanol (80 %) was added to 0.5 g sample in a round bottomed flask. The flask was connected to a condenser and kept on a heating mantle for 30 mins with occasional stirring. The extract was cooled, centrifuged at 8000 rpm for 15 min and the supernatant collected. The above procedure was repeated twice, each time extracting the residue in 25 ml 80 per cent ethanol. The combined extract in the beaker was evaporated to dryness on a boiling water bath. The residue was dissolved in distilled water and made to 50 ml. The sugar free pellet obtained after centrifugation was used for estimation of starch.

Total soluble sugars

Total soluble sugars were estimated by the method of Yemm and Willis (1954).

Reagents

(i) Standard sugar solution and standard curve: Dissolved 25 mg glucose in water and made to 100 ml. This solution contained 250 µg glucose per ml. For obtaining the standard curve, 0.1 ml to 1.0 ml of this solution was used.

(ii) Anthrone Reagent (0.2% anthrone in 70% H2SO4): This reagent was prepared fresh daily and allowed to stand for 30 to 40 min before use.

Estimation

Freshly prepared 10 ml anthrone reagent was pipetted in a test tube (150×25) and chilled in ice cold water. Out of the diluted sugar extract, one ml was taken and was layered on the anthrone reagent. After cooling for 3-5 mins, the contents were thoroughly mixed, while still immersed in ice cold water. The contents in the tube were heated vigorously in a boiling water bath for 10 min and then immediately cooled in cold water. The absorbance was then read at 625 nm in UV-

VIS spectrophotometer against a suitable blank. Amount of sugar was estimated by referring to the standard curve prepared with glucose. The total soluble sugars were calculated by the formula:

Total Soluble Sugars (%) =

$$\frac{C \times V \times 100}{W \times V1}$$

Where,
C = Concentration of glucose as calculated from the standard curve (µg)
V = Volume of extract made (ml)
W = Weight of sample taken (g)
V1 = Volume of aliquot taken (ml)

Reducing sugars

Reducing sugars were estimated by the Somogyi's modified method (Somogyi, 1945).

Reagents

Copper reagent (A): Dissolved 25 g anhydrous sodium carbonate, 25 g potassium sodium tartarate, 20 g sodium bicarbonate and 200 g anhydrous sodium sulphate in about 800 ml distilled water and diluted to one litre.

Copper reagent (B): Dissolved 15 g CuSO4 in 100 ml distilled water containing two drops of HCl.

Arsenomolybdate reagent: Dissolved 25 g ammonium molybdate in 450 ml distilled water by warming. Added 21 ml conc. H_2SO_4 with stirring. Three g sodium hydrogen arsenate dissolved in 25 ml distilled water was added with stirring. The solution was kept in an incubator at 37^OC for 24 h before use. This reagent was kept in a glass stoppered brown bottle and stored in refrigerator.

Copper Reagents: A and B were mixed in the ratio of 25:1 (V/V) before use.

Standard sugar solution: Dissolved 25 mg glucose in distilled water and volume was made to 100 ml. This contained 250 µg glucose/ml.

Estimation

One ml test extract was taken in blood sugar tube graduated at 25 ml. One ml mixed copper reagent (iv) was added and then heated for 20 min in a boiling water bath. To this one ml arsenomolybdate reagent was added, mixed thoroughly and the contents diluted to 25 ml. A stable blue color appeared quickly which was read at 520 nm against a suitable blank. The amount of reducing sugar was then determined by referring to the glucose standard curve and using the following formula:

$$\text{Reducing sugar (\%)} = \frac{C \times V}{W \times V_1 \times 1000} \times 100$$

Where,

C= Concentration of reducing sugar obtained from the standard curve (µg)
V= Volume of extract made (ml)
W= Weight of sample taken (g)
V1= Volume of aliquot taken (ml)

Non- reducing sugars

The amount of non-reducing sugars was calculated as the difference between total soluble sugars and reducing sugars.

Starch

Starch from the sugar free pellet obtained after centrifugation (by method of Cerning and Guilbolt, 1973) was estimated by the method of Clegg (1956).

Reagents

Perchloric acid (52%)

Extraction

Five ml water was added to the residue of test material and while stirring, 6.5 ml of 52 per cent perchloric acid was added. The contents were stirred continuously for 5 min. and then occasionally for next 15 minutes. To this 20 ml water was added and centrifuged at 8000 rpm for 20 minutes. The supernatant was collected in 100 ml volumetric flask. Five ml of water was added to the residue and repeated the extraction with 52 per cent perchloric acid stirring occasionally for next 30 minutes. The contents of the tube were washed into a volumetric flask containing the first extract. The combined extracts were diluted to 100 ml with distilled water and filtered, discarding the first 5 ml of the filtrate. A suitable aliquot of the extract was used for glucose estimation, using anthrone reagent by method of Yemm and Willis (1954). Starch was calculated using the following formula:

Starch= Glucose x 0.9

In vitro starch digestibility

In vitro starch digestibility was assessed by the method of (Singh *et al.*, 1982).

Reagents

Pancreatic amylase: Twenty mg pancreatic amylase was dissolved in 50 ml 0.2 M phosphate buffer (pH 6.9).

0.2 M Disodium hydrogen phosphate: Dissolved 35.39 g disodium hydrogen phosphate in distilled water and volume was made to one liter.

0.2 M Potassium dihydrogen phosphate: Dissolved 27.28 g potassium dihydrogen phosphate in distilled water and volume was made to one liter.

0.2 M Phosphate buffer (pH 6.9): Added 50 ml of 0.2 M (27.28 g/liter) Potassium dihydrogen phosphate to 46.8 ml of 0.2 M (35.59 g/liter) disodium hydrogen phosphate and volume was made up to 200 ml.

Dinitrosalicylic reagent: 3, 5-dinitrosalicylic acid (10 g), sodium potassium tartrate (300 g) and sodium hydroxide (16 g) were dissolved in carbon dioxide free water and volume was made to 1 liter. The reagent was stored in brown bottle and protected from carbon dioxide.

Standard maltose solution: 100 mg Maltose monohydrate was dissolved in distilled water and volume was made up to 100 ml.

Estimation

Fifty mg defatted sample was dispersed in 1.0 ml of 0.2 M phosphate buffer (pH 6.9), 0.5 ml of pancreatic amylase was added to sample suspension and incubated in water bath at 370C for 2 hours with occasional shaking of test tubes. After incubation, 2 ml of dinitrosalicylic reagent was added quickly and the mixture was heated for 5 minutes in a boiling water bath. After cooling, the solution was made to 25 ml with distilled water and filtered through an ordinary filter. An absorbance was measured at 550 nm.

A blank was run simultaneously by incubating the sample without enzyme. Dinitrosalicylic reagent was added before addition of the enzyme solution. Maltose was used as standard and values were expressed as mg maltose released/g defatted sample. Standard curve was prepared by taking 0.2 to 1.0 mg maltose released per gram sample from a standard maltose solution. The starch digestibility was calculated as:

In vitro starch digestibility =

$$\frac{\text{Concentration from graph (mg)}}{\text{Weight of sample (g)}}$$

In vitro protein digestibility

In vitro protein digestibility was determined by the modified method of Mertz *et al.*, (1983).

Reagents

Pepsin reagent: 0.1 M KH2PO4 (pH 2.0) containing 0.2 % pepsin; 13.6 g potassium dihydrogen phosphate was dissolved in 1 litre of water, pH of the solution was adjusted to 2.0 and then 2 g pepsin was dissolved in the buffer.

TCA (50 %): 50 g Trichloroacetic acid was dissolved in water and volume was made to 100 ml.

Procedure

250 mg of sample was weighed and transferred to a centrifuge tube. To it 20 ml of pepsin reagent was added. The tube was stoppered and arranged in a shaker-incubator maintaining the water temperature at 37□ C for 3 hours. Then centrifuge tube was removed and cooled. 5 ml of TCA (50 %) was added and the contents were centrifuged at 10,000 rpm for 10 mins at room temperature and filtered. Ten ml of aliquot was taken and dried in hot air oven dried aliquot was digested for nitrogen determination by micro kjeldahl method (AOAC, 2000). Digested protein of sample was determined. Protein digestibility was calculated by the following formula:

$$\text{Protein digestibility (\%)} = \frac{\text{Digested protein}}{\text{Total protein}} \times 100$$

Anti-nutritional factors

Phytic acid

Phytic acid content was determined by the method of Davies and Reid (1979).

Reagents

Nitric acid (0.5M): HNO3 69.5 % (15.96 ml) (AR grade, sp. gr.1.42) was diluted to 500 ml with distilled water.

Ferric ammonium sulphate: Ferric ammonium sulphate (216 mg) was dissolved in distilled water. To it few drops of HCl were added and volume was made to 500 ml with distilled water.

Ammonium thiocyanate: Ammonium thiocyanate (10g) was dissolved in distilled water and volume was made to 100 ml.

Iso-amyl alcohol

Sodium phytate: Dissolved 30.54 mg Sodium phytate (5.5 % H2O, 97 % purity and containing 12 Na/mole) in 100 ml of 0.5 M HNO3, which gave a solution containing 20 mg phytic acid in 100 ml or 200 µg phytic acid/ml or 0.2 mg phytic acid/ml.

Extraction

Extracted 500 mg well ground sample, with 20 ml 0.5 M HNO3 in conical flask for 3 h with continuous shaking on shaker at room temperature. After proper shaking it was filtered through Whatman No. 1 filter paper. Filtrate was used for estimation of phytic acid.

Procedure

To a test tube, 0.5 ml HNO3 extract was taken in stoppered test tube and volume was made to 1.4 ml with 0.9 ml water. To it, 1 ml

ferric ammonium sulphate solution wad added, the contents were thoroughly mixed and placed in boiling water bath for 20 min. immediately the tubes were cooled to room temperature under running tap water. Five ml iso-amyl alcohol was added to it, the contents were mixed vigorously and to it, 0.1 ml ammonium thiocyanate solution was added. The tubes were shaken well and centrifuged at 3000 rpm for 10 min. Color intensity in the alcohol was read exactly after 15 min of addition of ammonium thiocyanate at 465 nm against iso-amyl alcohol blank.

For plotting a standard curve, 0.2 to 1.2 ml standard sodium phytate solution containing 40-240 µg phytic acid was taken and made volume to 1.4 ml with water. (0.412 OD corresponded to 180 µg phytic acid).

The phytic acid was calculated by the formula:

$$\text{Phytic acid (mg/100g)} = \frac{M \times V \times 100}{W \times V1 \times 1000}$$

Where,
M = Concentration of sample for graph
V = Volume of extract made
W = Weight of sample
V1 = Volume of aliquot taken

Polyphenols

Total polyphenols were extracted by the method of Singh and Jambunathan (1981). Defatted sample (500 mg) was refluxed with 50 ml methanol containing one per cent HCl for 4 h. The extract was concentrated by evaporating methanol on a boiling water bath and brought its volume to 25 ml with methanol–HCl. The amount of polyphenolic compounds were estimated as tannic acid equivalent according to Folin-Davis procedure (Swain and Hills, 1959).

Reagents

Folin-Denis reagent: To 750 ml water, 100 g sodium tungstate, 20 g phosphomolybdic acid and 50 ml phosphoric acid were added and heated and then refluxed for 2 h. It was cooled and diluted to one liter.

Tannic acid stock solution: 100 mg of tannic acid was dissolved in distilled water and volume was made up to one liter. In order to have working standard solution, 20 ml of stock solution was further diluted to 100 ml with water. This solution contained 20 µg tannic acid per ml.

Saturated aqueous sodium carbonate solution: Dissolved 35.0 g sodium carbonate in hot distilled water (70oC to 80oC), cooled and filtered through glass wool and made volume to 1 liter.

Procedure

Test solution (1.5 ml) was diluted with distilled water to 8.5 ml in a graduated test tube. After thorough mixing, added 0.5 ml Folin- Denis reagent and the tubes were well shaken. Exactly after 3 minutes, one ml of saturated sodium carbonate solution was added and the tubes were thoroughly shaken again. After an hour, the absorbance was read at 725 nm on UV- VIS Spectrophotometer-118 using a suitable blank. If the solution was cloudy or precipitates appeared, it was centrifuged before readings were taken. A standard curve was plotted by taking 0.5 ml to 4.0 ml working tannic standard solution containing 10 µg to 80 µg tannic acid.

$$\text{Polyphenols (mg/100g)} = \frac{M \times V \times 100}{W \times V1 \times 1000}$$

Where,
M = Concentration of extract elute obtained

from graph
V = Volume made of extract (ml)
W = Weight of the sample (g)
V1 = Volume of extract aliquot taken (ml)

Fat acidity

The fat acidity was determined by the standard method of analysis (AOAC, 2000).

Reagents

Benzene-alcohol-phenolpthalein solution (0.02%): To one liter benzene, one liter alcohol and 0.4 g phenolphthalein was added and mixed.
Potassium hydroxide solution (0.0178 N).

Procedure

Ten gram sample was extracted with petroleum ether on Soxhelet apparatus. The solvent of the extract was completely evaporated on steam bath. The residue was dissolved in extraction flask with 50ml benzene-alcohol-phenolpthalein solution and titrated with standard potassium hydroxide (1g/lit) to orange pink color. Blank titration was made on 50ml benzene-alcohol-phenolpthalein and this value was substracted from titration value of the sample. Fat acidity was calculated as mg of potassium hydroxide required to neutralize free fatty acids of 100g of flour.

$$\text{Fat acidity} = 10 \times (T-B)$$

Where,
T = ml of KOH required to titrate sample extract
B = ml KOH required to titrate blank

Peroxide value

Peroxide value of stored products at 0, 15, 30, 45, 60, 75 and 90 days was determined by the method of AOAC (2000).

Reagents

Acetic acid : chloroform solution (3 : 2, v/v)
Saturated potassium iodide solution
0.01 N sodium thiosulphate solution
Starch solution: One gram soluble starch was dissolved in cold distilled water to make thick paste. Then boiled distilled water was added and boiled for one minute while stirring. When completely dissolved, the volume was made to 100 ml.
Potassium hydroxide solution (0.0178 N)

Procedure

Five gram sample was taken in conical flask. Thirty ml acetic acid-chloroform mixture was added to the flask and swirled to dissolve. Then 0.5 ml saturated potassium iodide solution was added. Kept for one minute with occasional shaking and 30 ml distilled water was added. This was slowly titrated against 0.01 N sodium thiosulphate with vigorous shaking until yellow color almost disappeared. Then 0.05 ml starch solution was added and titration continued with shaking vigorously to release all iodine from chloroform layer until blue color just disappeared. The blank was run in the similar way. Peroxide value was calculated as

$$\text{Peroxide value (meq peroxide/100g)} = \frac{(S-B) \times N \times 1000}{\text{Weight of sample}}$$

Where,
B = Volume (ml) of $Na_2S_2O_3$ used for titration of blank
S = Volume (ml) of $Na_2S_2O_3$ used for titration of sample
N = Normality of $Na_2S_2O_3$ solution

Statistical analysis

Suitable standard statistical methods were used for analysis of data (Sheoran and Pannu, 1999).

Results and Discussion

Total soluble, reducing and non-reducing sugars

Total soluble sugar content of control *sev* was 3.77%, which was significantly (P≤0.05) lower than that of wheat, sorghum and soybean composite flour *sev* developed from WH-1129 wheat flour 4.64 per cent and HD-2967 flour 4.37 per cent (Table 1). There was non- significant difference in the reducing sugar content of control *sev* (0.68%) and *sev* prepared from WH-1129 flour (0.56%) and HD-2967 (0.62%) wheat flour supplemented *sev*. Non- reducing sugar content of control *sev* was significantly (P≤0.05) lower i.e. 3.08 per cent than that of WH-1129 flour (5.25%) and HD-2967 wheat flour (4.65%) *sev*. Supplemented WH- 1129 wheat flour *sev* contained higher amount of total soluble sugar (4.64%) and non- reducing sugar (5.25%) than that of HD-2967 wheat flour *sev*. The starch content of control *sev* (58.49%) was higher than that of supplemented *sev*. The results of present study corroborated with the findings of (Gupta, 2001; Ayo *et al.*, 2007; Sangwan and Dahiya, 2013; Rana, 2015). The differences in sugar content of value added *sev* might be due to the differences in carbohydrate content of raw ingredients and different types of flours used for product development.

In vitro starch and protein digestibility

The data regarding *in vitro* starch and protein digestibility of control and one most acceptable ratio of sorghum and soybean incorporated value added *sev* are presented in Table. 2.

The starch and protein digestibility was 45.44 mg maltose released/g meal and 71.03 per cent, in the control *sev* which was significantly (P≤0.05) higher than that of both types of value added *sevs* developed from wheat, sorghum and soybean composite flours. The starch and protein digestibility was 43.83 mg maltose released/g meal and 68.77 per cent, respectively for WH-1129 supplemented *sev* while HD-2967 supplemented *sev* had starch digestibility (43.52 mg maltose released/g meal) and protein digestibility (68.17%) which was significantly (P≤0.05) lower than that of WH-1129 supplemented *sev*. The differences in starch and protein digestibility of control and supplemented *sev* might be due to differences in the starch and protein contents of raw flours used for the development of extruded product. The results of the study corroborated with those of (Hooda, 2002; Sangwan, 2002).

Anti-nutritional factors

The data pertaining to anti-nutritional factors *viz*. phytic acid and polyphenol content of acceptable value added *sevs* developed from sorghum and soybean composite flours are presented in Table. 3.

Control *sev* prepared from 100 % wheat flour had 189.09 mg/100g phytic acid and 215.07 g/100g, polyphenol which was significantly (P<0.05) lower than that of both types of supplemented *sev* prepared from wheat, sorghum and soybean flours. The phytic acid and polyphenol contents of WH-1129 supplemented *sev* were 281.07 and 245.10 mg/100g, respectively whereas HD-2967 supplemented *sev* had 274.03 and 255.03 mg/100g of phytic acid and polyphenol contents, respectively at 40:40:20 supplementation level. WH-1129 flour supplemented *sev* exhibited significantly (P<0.05) higher contents of phytic acid and significantly (P<0.05) lower contents of

polyphenol in comparison to HD-2967 supplemented *sev*.

NS = Non-significant

Similar results were found in value added *sev* incorporated sorghum and soybean flours in wheat flour. This difference was due to higher content of anti-nutritional factors in sorghum and soybean flours compared to wheat flours. The results of present study are in agreement with the other workers (Sangwan, 2002; Rana, 2015). A negative correlation was found between anti-nutritional factors and *in vitro* digestibility of supplemented products (Sangwan, 2002).

Table.1 Total soluble sugars, reducing sugars, non-reducing sugar and starch content of sorghum and soybean incorporated value added *sev* (%, on dry matter basis)

Supplementation level (%)	Total soluble sugars	Reducing sugars	Non-reducing sugars	Starch
Sev				
Control (100% WF)	3.77±0.07	0.68±0.14	3.08±0.09	58.49±0.14
WH-1129:SGF:SBF (40:40:20)	4.64±0.06	0.56±0.11	5.25±0.12	54.38±0.10
HD-2967:SGF:SBF (40:40:20)	4.37±0.08	0.62±0.06	4.65±0.15	54.65±0.08
CD(P≤0.05)	0.24	N.S	0.29	0.38

Values are mean ± SE of three independent determinations
WF = Wheat Flour, WH– 1129= Wheat Flour, SGF = Sorghum Flour, SBF = Soybean Flour, HD-2967=Wheat Flour, NS = Non-significant

Table.2 *In vitro* starch and protein digestibility of sorghum and soybean incorporated value added *sev* (on dry matter basis)

Supplementation level (%)	Starch digestibility (mg maltose released/g meal)	Protein digestibility (%)
Sev		
Control (100% WF)	45.44±0.26	71.03±0.04
WH-1129:SGF:SBF (40:40:20)	43.83±0.06	68.77±0.07
HD-2967:SGF:SBF (40:40:20)	43.52±0.09	68.17±0.07
CD(P≤0.05)	0.26	0.22

Values are mean ± SE of three independent determinations
WF = Wheat Flour, WH– 1129= Wheat Flour, SGF = Sorghum Flour, SBF = Soybean Flour, HD-2967=Wheat Flour, NS = Non-significant

Table.3 Phytic acid and Polyphenol content of sorghum and soybean incorporated value added *sev* (mg/100g, on dry matter basis)

Supplementation level (%)	Phytic acid	Polyphenol
Sev		
Control (100% WF)	189.09±0.89	215.07±0.54
WH-1129:SGF:SBF (40:40:20)	281.07±0.70	245.10±0.56
HD-2967:SGF:SBF (40:40:20)	274.03±0.80	255.03±0.74
CD(P≤0.05)	2.81	2.19

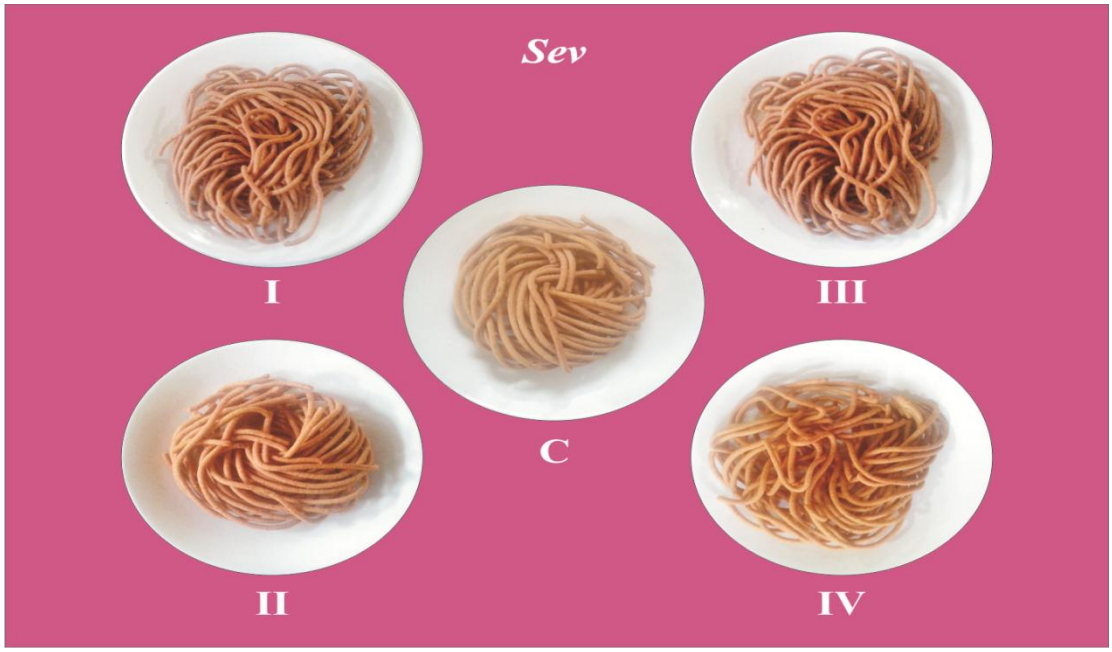
Values are mean ± SE of three independent determinations
WF = Wheat Flour, WH– 1129= Wheat Flour, SGF = Sorghum Flour, SBF = Soybean Flour, HD-2967=Wheat Flour, NS = Non-significant

Table.4 Effect of storage period on fat acidity (mg KOH/100gm) of wheat, sorghum and soybean composite flour *sev* (on dry weight basis)

Supplementation level (%)	Storage period (days)							Mean
	0	15	30	45	60	75	90	
Control (100% WF)	28.00±1.20	30.00±1.25	33.00±1.25	39.00±2.33	45.00±1.20	54.33±0.88	63.00±0.88	41.76
WH-1129:SGF:SBF (60:30:10)	33.67±2.33	36.33±1.85	39.00±2.02	42.00±1.45	48.00±0.88	57.00±2.33	66.00±2.02	46.00
WH-1129:SGF:SBF (40:40:20)	37.67±2.34	39.67±2.33	43.33±2.08	46.33±0.88	52.33±0.67	60.67±1.20	70.33±0.88	50.05
HD-2967:SGF:SBF (60:30:10)	36.33±0.88	38.33±2.08	41.33±1.20	44.33±2.08	50.33±2.08	59.34±0.88	68.33±0.99	48.33
HD-2967:SGF:SBF (40:40:20)	40.33±2.08	42.33±2.10	45.67±2.02	48.33±0.88	54.33±1.45	63.33±1.25	72.33±1.45	52.38
Mean	34.44	36.56	39.67	43.11	49.11	58.06	67.11	
CD(P≤0.05)	Period : 2.15		Supplementation level : 1.99			Period × Supplementation level : NS		

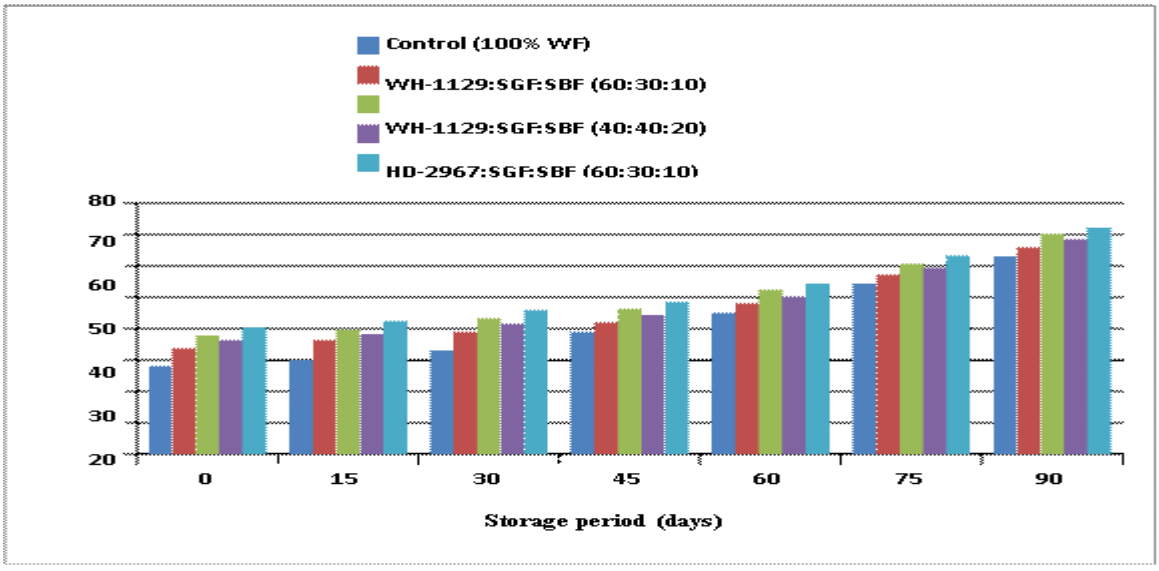
Values are mean ± SE of three independent determinations, WF = Wheat Flour, WH– 1129= Wheat Flour, SGF = Sorghum Flour, SBF = Soybean Flour, HD-2967=Wheat Flour

Sorghum-Soybean incorporated value added *sev*



C = Control (C-306)
I = Wheat flour (WH-1129) + Sorghum flour+ Soybean flour (60:30:10)
II = Wheat flour (WH-1129) + Sorghum flour+ Soybean flour (40:40:20)
III = Wheat flour (HD-2967) + Sorghum flour+ Soybean flour (60:30:10)
IV = Wheat flour (HD-2967) + Sorghum flour+ Soybean flour (40:40:20)

Fig.1 Effect of storage period on fat acidity of value added *sev*



Fat acidity

The fat acidity content of control *sev* increased significantly (P≤0.05) during storage period ranged from 28.00 (0 day) to 63.00 (90 days) mg KOH/100g (Fig. 1 & Table 4). The fat acidity of WH-1129:SGF:SBF (60:30:10) and (40:40:20) increased from 33.67 to 66.00 and 37.67 to 70.33 mg KOH/100g, respectively and that of HD:SGF:SBF (60:30:10) and (40:40:20) increased from 36.33 to 68.33 and 40.33 to 72.33 mg KOH/100g, respectively during zero to 90 days of storage. There was a significant (P≤0.05) increase in the fat acidity of all types *sev* from zero to 90 days of storage period.

Sorghum and soybean flours incorporated value added *sevs* had maximum fat acidity as compared to all their respective control and this might be due to high fat content in the flour blends. Though there was increase in the fat acidity of *sev* during the storage but this increase was within the permissible limits. Results of the present study corroborated with those of other investigators (Hooda, 2002; Sangwan, 2002; Rana, 2015). Our findings also lend support to those of Supraja (2001) and Chandel (2014) who reported that fat acidity of control and value added *sev* increased on increasing the storage period. Increase in fat acidity could be attributed to the hydrolysis of triglycerides resulting in formation of free fatty acids which increase the fat acidity (Kapoor and Kapoor, 1990).

Peroxide value

The peroxide value of control and value added *sev* were not detected up to 90 days of storage period at room temperature (in winter season). These results clearly indicated the effectiveness of cooking process in reducing the lipolytic activity in the value added *sev* and hence no rancidity was found in value added *sev* during storage. The results of the present study are in close agreement with those of (Hooda, 2002 and Sangwan, 2002).

From the findings of the present study it is concluded that sorghum-soybean incorporated value added *sev* developed from WH-1129 wheat variety was nutritionally superior to that of HD-2967 variety. The *sev* prepared from both the wheat varieties i.e. WH-1129 and HD-2967 were found to have better nutritive value than control and could be stored safely up to 90 days. Hence, it is recommended that value added *sev* which are nutritionally rich and organoleptically acceptable should be commercialized and promoted for use among population through on- going nutrition intervention programs. Considering the present scenario of environment it would be a smart idea to endorse the promotion of sorghum based value added products enriched with soybean. This stratagem will go a long way in protecting environment and improving the nutritional status of the population especially growing children. Moreover, the production of these value added *sev* if taken on small scale or large scale as an entrepreneurial activity and will help to raise the socio-economic status of not only farmer but also rural population at large.

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