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Hypocaloric Fruit Spreads to Smack Healthy Snacks

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Abstract
Aonla is an important fruit of India and is consumed fresh, processed and preserved in several ways. Hempseeds have the potential to contribute to nutrition, health and income generation but still it is an underutilized crop and is yet to be adopted by large scale agriculturalists. The present study has been undertaken with a view to analyze the chemical and mineral composition of Alona fruit leather and hempseed and to optimize the incorporation of hempseeds into the Alona fruit leather and jam using sensory evaluation technique. The chemical and mineral characteristics of formulated products namely Alona- hempseed incorporated fruit leather and jam were determined and compared with the Alona fruit leather and jam. The moisture content of Alona and hempseed were 6.38, 33.42, 21.31, 13.45 per cent and 456.33 kcal per 100g respectively on dry weight basis. The Alona fruit had pH of 2.5, TSS- 12.35, Titrable acidity – 1.72, reducing sugars – 2.35, non-reducing sugars- 0.76, total sugars – 3.45, pectin – 0.88 per cent, tannins – 3.11 mg per 100g and ascorbic acid – 613.23 mg per 100g. The mineral content of Alona and hempseed was analyzed. The Alona contained calcium – 46.21, iron – 1.03, zinc – 0.99, sodium – 5.77, potassium – 239.06 and magnesium – 9.28 mg per 100g on fresh weight basis whereas the corresponding values of hempseed flour were calcium – 178.51, iron – 21.48, zinc – 7.03, sodium – 12.90, potassium – 835.81 and magnesium- 537.39 mg per 100g on dry weight basis. Optimization of the basic recipe for control and different levels of hempseed flour incorporated Alona fruit leather and jam was done. Optimization process comprises of optimization of sugar content used for making pulp- sugar blend and different levels of hempseed for the incorporation in Alona fruit leather and jam. Among the samples of Alona – hempseed fruit leather and jam prepared, the most acceptable sample was obtained from 350 g Alona pulp, 5 g hempseed flour and sugar concentration of 75 per cent of Alona pulp i.e. 270g. There was non-significant difference with regard to the appearance, texture, taste, flavour, mouth feel and overall acceptability of 5g hempseed incorporated Alona fruit leather whereas there was non-significant difference with regard to the colour, appearance, texture, taste, flavour, mouth feel and overall acceptability of 5g hempseed incorporated Alona jam when compared with control. Chemical evaluation of formulated products was done and it was compared with the control Alona fruit leather and jam. The protein and the mineral content of the formulated products were higher than the protein and mineral content of control Alona products. Thus from the present study it was concluded that the Alona products namely fruit leather and jam can be made successfully with the incorporation of hempseeds so as to increase the medicinal as well as nutritional value of the products.

Keywords: Aonla, incorporated, flour, medicinal, corresponding, control

Introduction
Fruits are among the first food items known to human beings. Fruits, whether fresh or dried, have always formed a part of the staple diet of human beings. The reason for this is that they nourish the body with minerals and vitamins. Apart from that fruits are important components of a healthy diet, and that their consumption could help prevent to a wide range of diseases. Fruits are plant products with aromatic flavour that are naturally sweet or normally sweetened before eating (Salunkhe and Desai, 1984) [22]. They contain low molecular weight sugars or high molecular weight polymers like starch, cellulose, hemicelluloses, pectin substances and lignin which are exploited for dietary fiber. Also fruits have gained commercial importance and have become an important sector of food industry. Aonla (*Phyllanthus emblica* or *Emblica officinalis* Gaertn.) is one of the oldest minor sub- tropical deciduous tree. It belongs to the family, Euphorbiaceae and is native of India, Sri Lanka, Malaysia and China (Kalra, 1988) [13]. It is also known as Amla, Indian Gooseberry, Dhatri, Amali, Aawallaa, Aamalaki, Embelic, Nellikai, Nillika, Aamvala, Usareekai, Nelli, Amlakamu, Amlakand in different parts of India, Nepal and other Asian countries (Kumar and Sagar, 2009) [16].

Aonla is very popular in India and is commercially cultivated in different parts of Uttar Pradesh (Bajpai and Shukla, 1985) [4]. This is followed by Gujarat and Rajasthan with an annual production of 30 million tonnes and 6 million tonnes respectively. Traditionally, the fruit is useful as it is astringent, cardiac tonic, diuretic, laxative, liver tonic, refrigerant, stomachic, restorative, antipyretic, anti- inflammatory, hair tonic, and digestive medicine. Aonla is a rare example of an edible material, which is rich in tannins as well as ascorbic acid (Kalra, 1988) [13]. The vitamin C content in Aonla varies from 200-900 mg/100g depending upon the variety and size of the fruit (Barthakur and Arnold, 1991) [6]. Aonla is presently underutilized fruit, but has enormous potential in the world market.

Hemp (Cannabis sativa L.), an annual herbaceous plant, belongs to Cannabaceae family. Industrial hemp is a class of non- drug Cannabis sativa varieties, and hempseed is technically as

achene, or nut (USDA, 2000) [27]. Cannabis sativa (the Latin term for ('useful hemp') is a very important plant by economical point of view for fibers, seeds, oils as well s for the chemical constituents with large medicinal value and uses in some diseases therapy or in amelioration of certain health problems. Hempseed, technically a nut, contains 20-25% protein, 20-30% carbohydrates, 25-35% oil and 10-15% insoluble fiber and a rich array of minerals, particularly phosphorous, potassium, magnesium, sulphur and calcium alongwith modest amounts of iron (14 mg/100g) and zinc (Deferne and Pate, 1996; Pate, 1999) [8, 19]. Hempseed, in addition to its nutritional value, has demonstrated positive health benefits, including the lowering of cholesterol and high blood pressure (Jones, 1995) [12]. Hemp also mitigates cough, is carminative, easily digestible, aphrodisiac and used as an exhilarant (Khare, 2004) [14]. Jams, jellies, fruit bar and preserves are manufactured as one of the important fruit by products in industries and based upon the high solids- high acid principle. In addition to the pleasing taste of such preserved fruits, they also possess substantial nutritive value (Manay and Shadaksharaswamy, 2005) [18]. Fruit leather or slab or bar is a concentrated product with good nutritive value. It is the product prepared by blending pulp/puree from sound, ripe fruits, fresh or previously preserved nutritive sweeteners, butter or other edible vegetable fat or milk solids and other ingredients appropriate to the product and dehydrated to form sheet which can be cut to desired shape or size. The product is hygienic, has a good shelf life and convenient to use. Hence the study was undertaken with the objectives of estimation of nutritional composition of hempseeds and chemical composition of Alona fruit.

Materials and Methods

Procurement of raw materials: Aonla fruit as well as castor sugar were procured from the local market of Pantnagar, Uttarakhand. Hempseeds for the purpose of research work were procured from the local market of Haldwani, Uttarakhand.

Cleaning and Grinding of Hempseeds

For cleaning, hempseeds were washed, sun dried for one day and manually cleaned to remove stones, grits, chaff and other impurities. After sun drying the seeds were oven dried at 60º C for 3 hours before grinding. The oven dried seeds were then ground with the grinding stone. The flour made was the sieved out manually and some amount of fiber was lost in the sieved (with mesh size 40) out material and there after the prepared sample was packed in air tight containers and stored at room temperature until used.

Chemical Analysis of Hempseed Flour

The chemical analysis was done in triplicates. The hempseeds were analysed for proximate composition (AOAC, 1995) [3]. The carbohydrate content was determined by subtracting the sum of the values (per 100 g) for moisture, total ash, crude fat, crude fibre and crude protein from hundred. The calorific value (Kcal per 100g) of sample was calculated by summing up the product of multiplication of per cent crude protein, crude fat and carbohydrate present in the sample by 4, 9, and 4, respectively.

Estimation of Minerals

The minerals were estimated by preparation of ash solution by AOAC (1975) [2] method. Calcium content was determined by titrimetric method of AOAC (1975) [2]. Iron, zinc, sodium, potassium and magnesium content was estimated using atomic absorption spectrophotometer after preparation of ash solution by wet ashing procedure as described by Raghuramulu (2003) [20].

Product Formulation and Standardization of Recipe Preparation of Aonla Pulp

Fully matured and fresh Alona fruits free from bruises and cracks were selected for the preparation of Aonla pulp. The selected fruits were thoroughly washed and cleaned in running water to remove any adhering dirt. The method for the preparation of Aonla pulp is given in Fig 1. The Aonla fruits were pressure cooked in water for 3 minutes. The fruits were cooled at room temperature so that destining can be easily done. Pressure cooked fruits were degritted to remove the seeds with the help of hands or stainless steel knife. Pulp was extracted by adding previously used water in pressure cooked segments of fruits in the ratio (fruit: water = 1:1) and was blended in electric blender.

Product Formulation

Two types of products namely fruit leather and jam were developed.

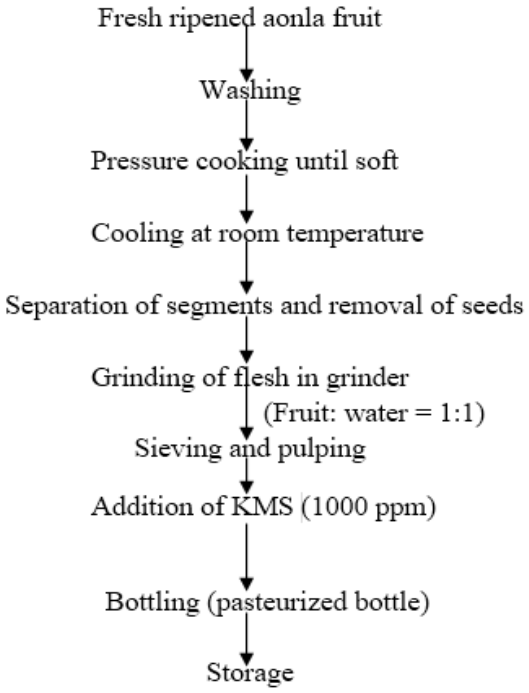

Fig 1: Flow Chart for the Preparation of Aonla Pulp

A. Aonla Fruit Leather Extraction of Pulp

The pulp extracted and preserved by the method as described previously in Fig 1. Was used to prepare Aonla fruit leather or slab.

Formulation of Recipes

Four samples of Aonla fruit leather were prepared by adjusting TSS content of pulp- sugar blend to 35%, 40%, 45% and 50% with the incorporation of required amount of sugar. The prepared product samples were presented to a panel of ten judges for the sensory evaluation using Score Card and Nine Point Hedonic Rating Scale so as to select to an ideal recipe.

Preparation of Aonla Fruit Leather

To a pre weighed amount of pulp taken in a stainless steel pan, the required quantity of castor sugar was added. The pulp- sugar blend was heated for 5- 10 minutes or until the sugar was solubilized. Thereafter, the mix was spread uniformly (thickness 1 cm) in an aluminum tray having a very thin coating of glycerol layer so as to avoid the sticking of dried product. The content was dried in a hot air oven at a temperature of 55º – 60º C for 20 hours turning both the sides till it attained a leathery consistency. The dried sheet of slab after cooling was cut into rectangular shape pieces as represented in Figure 2. Ingredients used in the preparation of Aonla fruit leather given in Table 1.

Table 1: Ingredients Used in the Preparation of Aonla Fruit Leather

Ingredients	Recipe No.1 (35% TSS)	Recipe No. 2 (40% TSS)	Recipe No. 3 (45% TSS)	Recipe No. 4 (50% TSS)
Aonla pulp	125g	125g	125g	125g
Sugar	75g	85g	90g	100g

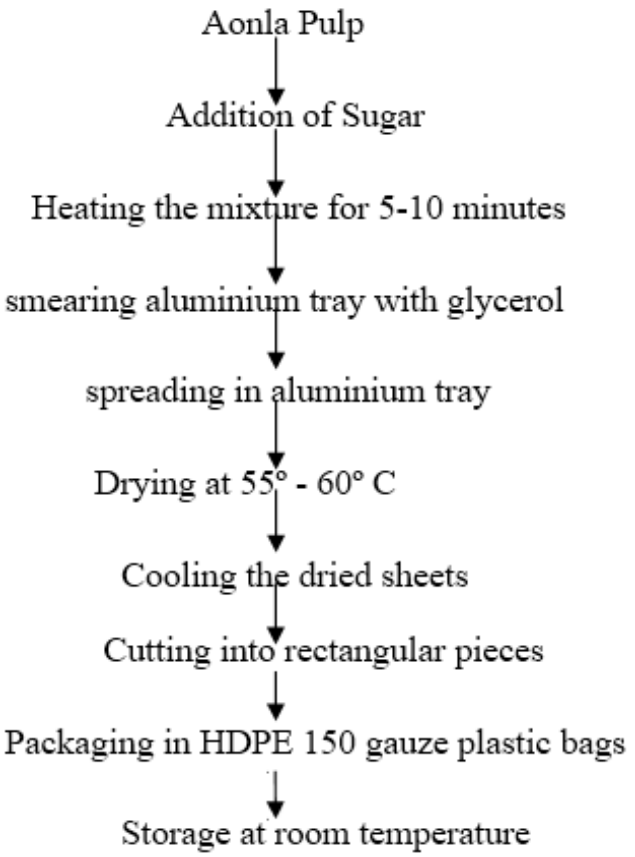

Fig 2: Flow Chart for the Preparation of Aonla Fruit Leather

B. Aonla Jam: Extraction of Pulp

The pulp extracted and preserved by the method as described previously in Fig 3.was used to prepare Aonla jam.

Formulation of Recipes

Two samples of Aonla jam were prepared by using different concentrations of sugar i.e. 75% and 100%. The prepared product samples were presented to a panel of ten judges for the sensory evaluation using Score Card Method and Nine Point Hedonic Rating Scale so as to select the best combination.

Preparation of Aonla Jam

For the preparation of Aonla jam of 45% fruit content and 68% TSS using a pulp of 98% fruit content, desired amount of sugar was added to the pulp and mixture was transferred in an open stainless steel pan. The mixture was heated on a gas burner at low flame temperature and TSS was monitored during boiling. Heating was stopped when TSS reached 65 - 66º Brix and the mixture was poured into clean, dry, sterilized wide mouth 350 ml glass bottles and cooled under ambient condition. The bottles were then covered with the butter paper to prevent microbial growth and stored for 24 h for proper setting of jam to 68.5º Brix. Ingredients used in the preparation of Aonla jam are given in Table 2.

Table 2: Ingredients Used in the Preparation of Aonla Jam

Ingredients	Recipe No. 1	Recipe No. 2
Aonla Pulp	350g	350g
Sugar	270g	350g

*Recipe no. 1(sugar) – 75% of Alona pulp
Recipe no.2 (sugar) – 100% of Alona pulp

Development of Recipe for Preparing Aonla- hempseeds incorporated Products

The selected formulations in the previous experiments for preparation of Alona fruit leather and jam from Alona pulp were used as the base recipes for developing the products from Alona and hemp seeds. Preserved Alona pulp was employed in the preparation of Alona- hempseeds incorporated products. Clean and oven dried hemp seeds were ground with grinding stone and the powder thus obtained was packed in air tight container.

A. Preparation of Aonla- Hempseed Incorporated Fruit Leather

A well accepted level of sugar was selected for preparing quality Alona fruit leather in the earlier experiment on the basis of higher overall acceptability rating. The level of TSS (45%) was used in the development of Alona- hempseed incorporated fruit leather.

Four samples of Alona- hempseed incorporated fruit leather were prepared by adding different levels (0, 5, 10 and 15%) of hemp seed flour to Alona pulp. Hempseed incorporated fruit leather samples were prepared and subjected to sensory evaluation as described earlier.

B. Preparation of Aonla- Hempseed incorporated Jam

A well accepted level of sugar (75% of Aonla pulp) was selected for preparing Aonla jam in the earlier experiment on the basis of higher overall acceptability rating. The sugar level (75%) was used in the development of Aonla- hempseed incorporated jam. Four samples of Aonla- hempseed incorporated jam were prepared by adding different levels (0, 5, 10 and 15 %) of hemp seed flour to Aonla pulp. Incorporated jam samples were prepared and subjected to sensory evaluation as described earlier.

Chemical Analysis of Aonla fruit and formulated products
The chemical analysis of Aonla fruit and formulated products was done in triplicates. The moisture content was determined by procedure as given by (Ranganna, 1991) [6].The protein content was determined by Micro Kjeldahl method of Ranganna (1991) [6]. The pH of the samples was noted by the help of pH meter (Systronic Make) after its calibration. The total soluble solids (TSS) content of the flesh following pulp was determined using Hand Refract meter (Erma make). The content of reducing and total sugars was estimated by Lane and Eynon method (1923) as described by Ranganna (1991) [6]. The tannin content was estimated by determining their oxidizing ability by potassium permanganate solution (i.e. volumetric method) by (Ranganna, 1991). The pectin content (as calcium pectate) was determined in percentage on the basis of flesh weight (Ranganna, 1991) [6]. Ascorbic acid was determined by method as described by Ranganna, 1991 [6].

Estimation of minerals
The ash solution was prepared by the method described by (AOAC, 1975) [2]. The calcium content was determined by titrimetric method of AOAC (1975) [2]. However the iron, zinc, sodium, potassium and magnesium contents were estimated using atomic absorption spectrophotometer after preparation of ash solution using wet ashing procedure as described by Raghuramulu (2003) [20].

Sensory Evaluation
Fruit leather and jam were evaluated for their sensory characteristics namely colour, flavour, texture, taste, appearance, mouthfeel and overall acceptability using Score Card. Nine Point Hedonic Rating Scale (Larmond, 1982) was also used for the evaluation of acceptability of the product. Sensory evaluation was done by a semi- trained panel consisting of 10 members (Amerine *et al.,* 1965).

Results and Discussion
Aonla has relatively higher content of Vitamin C. Consumption of only 10 g (one average sized fruit) would meet the recommended dietary allowance for vitamin C. The present study was undertaken with a view to study the nutritional quality of Aonla and hempseeds available in the local market.

Chemical Evaluation of Aonla Fruit Moisture
The moisture content of fresh fruit of Aonla was 80.88 per cent on fresh weight basis (Table 3). Bajpai and Shukla (2002) [5] reported that 100 g of edible portion of Aonla fruit contained 81.2 g moisture which is slightly more (0.32 per cent) than the result obtained in the present study. Sethi and Anand (1985) [23] reported a range of 79-89 per cent of moisture content in Aonla fruit.

Crude protein
Bajpai and Shukla (2002) [5] of Aonla fruit as 0.5 per cent and is slightly lower than the value reported by Tripathi *et al.* (1988) [26] of Aonla fruit as 0.88 per cent.

PH
Tripathi et al. (1988) [26] of Aonla fruit as 2.5. However, Hulme (1971) [11] reported a value of 3.1 per cent for the pH content of Aonla (*E. officinalis*) which is slightly higher than the result obtained in the present study.

Titrable acidity (per cent citric acid)
The acidity in Aonla has been expressed in terms of per cent citric acid. The values of acidity content of Aonla fruit was obtained as 1.72 per cent on fresh weight basis. Sethi and Anand (1985) [23] reported a range of 0.99 -3.36 per cent for acidity content in the fresh fruits of Aonla. Therefore the result obtained is in accordance with the existing literature. Hulme (1971) [11] reported the acidity content as per citric acid of Aonla (*E. officinalis*) as 0.88 per cent.

Total Soluble Solids
Different Aonla cultivators harvested at full maturity differ greatly in their TSS content. The values of TSS content of Aonla fruit was obtained as 12.35 per cent on fresh weight basis (Table3) which is in accordance with the range given by Teotia *et al.* (1968) as 9.0 – 15.0 per cent. Tripathi *et al.* (1988) [26] reported a value of 14 per cent for the TSS content of Aonla which is 1.65 per cent higher than the result obtained in the present study.

Reducing Sugar
Sethi and Anand (1985) [23] reported a range 1.32 – 5.57 per cent for the reducing sugar content in the fresh fruits of Aonla. Tripathi *et al.* (1988) [26] reported 2.37 per cent reducing sugars in Aonla fruit which is slightly higher than the value reported obtained in the present study.

Non-Reducing Sugar
The values of reducing sugar content of Aonla fruit was obtained as 0.76 per cent on fresh weight basis (Table 3). Tripathi *et al.* (1988) [26] reported 0.74 per cent non – reducing sugars in Aonla fruit which is slightly lower than the value reported in the present study. Ghorai and Sethi (1996) [9] reported 1.8 per cent non-reducing sugars in Aonla fruits which are slightly higher than value obtained in the present study.

Total Sugar
Tripathi *et al.* (1988) [26] determined 3.11 per cent on fresh weight basis (Table 3). Tripathi *et al.* (1988) [26] determined 3.11 in the present study. Singh *et al.* (1993) [24] reported a range of the total sugar content of Aonla fruits as 3.5 to 4.9 per cent. Therefore the result obtained is in accordance with the existing literature.

Tannins
Sethi and Anand (1985) [23] stated that the astringent taste of Aonla fruit is due to tannins and reported a range of 4.45 – 5.57 per cent for the tannin content of Aonla fruit which is higher than the value reported in the present study. Tripathi *et al.* (1988) [26] reported tannin content of Aonla fruit as 0.55 per cent on fresh fruit basis.

Pectin
Hulme (1971) [11] reported that Aonla fruits contain approximately 0.5 per cent pectin which is slightly lower than the value reported in the present study. Tripathi *et al.* (1988) [26] also reported similar value for pectin content in Aonla fruit i.e. 0.54 per cent.

Ascorbic Acid
Singh *et al.* (1993) [24] reported a range 690- 881.8 mg per 100 g content of the acorbic acid in Aonla fruits which is higher than

the result obtained in the present study. Teotia *et al.* (1968) reported a range of 450- 665 mg per 100 g content of the ascorbic acid in Aonla fruits. Tripathi *et al.* (1988) [26] reported ascorbic acid content of Aonla fruit as 571.76 mg per 100 g on fresh fruit basis which is slightly lower than the results obtained in the present study.

Table 3: Chemical Characteristics of Aonla Fruit

Components	Average Value
Moisture (%)	80.88 ± 0.11
Crude Protein (%)	0.55 ± 0.05
pH	2.50 ± 0.01
Titrable Acidity (% as citric acid)	1.72 ± 0.10
Total Soluble Solids (ºBrix)	12.35 ± 0.05
Reducing Sugars (%)	2.35 ± 0.02
Non- Reducing Sugars (%)	0.76 ± 0.02
Total Sugars (%)	3.45 ± 0.33
Tannins (mg/100g)	3.11 ± 0.07
Pectin (%)	0.88 ± 0.02
Ascorbic Acid (mg/100g)	613.23 ± 2.92

Values are mean of triplicate observations ± S.D.

Calcium
Gopalan (1995) reported a value of 50 mg per 100 g for the calcium content of Aonla fruit, 3.79 mg higher than the calcium content of Aonla fruit obtained in the current study. Barthakur and Arnold (1991) [6] reported the calcium content of Aonla fruit as 27.6 mg per 100g.

Iron
Barthakur and Arnold (1991) [6] reported the iron content of Aonla fruit as 3.3 mg per 100 g.

Zinc
The zinc content of Aonla fruit was 0.99 mg per 100 g on fresh weight basis (Table 4) which is lower than the value (1.8 mg) reported by Barthakur and Arnold (1991) [6].

Sodium
Barthakur and Arnold (1991) [6] reported the sodium content of Aonla fruit as 4.2 mg per 100g.

Potassium
Barthakur and Arnold (1991) [6] reported the potassium content of Aonla fruit as 282 mg per 100 g.

Magnesium
Barthakur and Arnold (1991) reported the magnesium content of Aonla fruit as 11.8 mg per 100 g which is slightly higher than the value obtained in the current study.

Table 4: Mineral Composition of Aonla Fruit on as- is basis

Minerals (mg per 100 g)	Average Value
Calcium	46.21 ± 1.55
Iron	1.03 ± 0.22
Zinc	0.99 ± 0.19
Sodium	5.77 ± 0.66
Potassium	239.06 ± 4.05
Magnesium	9.28 ± 0.40

Values are mean of triplicate observations ± S.D.

Nutritional Quality Assessment of hempseeds Proximate Moisture of Hempseeds Moisture
Anwar *et al.* (2006) [1] reported a range of 5.60 to 8.50 per cent for the moisture content of hempseeds (*C.sativa*). Therefore the result obtained is in accordance with the existing literature values as in Table 5.

Total Ash
Anwar *et al.* (2006) [1] reported a range of 5-7.6 per cent for the total ash content of hempseeds (*C. staiva*) and the results of present study are within this range.

Crude Protein
Verma *et al.* (2010) [28] reported a value of 24.65 per cent for the protein content of hempseeds (C. sativa) which is 0.75 per cent lower than the result obtained whereas Callaway (2004) [7] reported a value of 24.80 per cent for the protein content of whole hempseeds (C.staiva) which is 0.6 per cent lower than the result obtained in the present study. The value obtained falls in the range of 23- 26.5 per cent reported by Anwar *et al.* (2006) [1].

Crude Fat
Kriese *et al.* (2004) [15] reported a range of 26.25 to 37.50 per cent for oil content in hempseeds. Therefore the result obtained is in accordance with the existing literature. However, Callaway (2004) [7] reported higher value for the lipid content of hempseeds i.e. 35.5 per cent.

Crude Fiber
Verma *et al.* (2001) [28] reported the crude fiber content of hempseeds as 18.12 per cent which is 3.19 per cent lower than the value obtained in the present study.

Table 5: Proximate Composition of Hempseeds on as- is basis and dry weight basis

Components	Hempseed	
	As is basis	Dry weight Basis
Moisture (%)	5.73 ±0.13	-
Ash (%)	6.01 ±0.04	6.38 ±0.04
Crude protein %)	23.98 ±0.12	25.44 ±0.13
Crude Fat (%)	31.50 ±0.24	33.42 ±0.25
Crude Fiber (%)	20.09 ±0.13	21.31 ±0.14
Carbohydrate by difference (%)	12.68 ±0.62	13.45 ±0.65
Energy (Kcal)	430.18 ±0.45	456.33 ±0.48

Values are mean of triplicate observations ± S.D.

Carbohydrate by Difference
The carbohydrate content of hempseeds is reported as 12.39 per cent on dry matter basis (Verma *et al.,* 2001) [28].

Physiological Energy
Verma *et al.* (2001) [28] reported the energy value for hempseeds as 424 kcal per 100 g which is 32 kcal less than the energy value reported in the current study. Callaway (2004) [7] reported a value of 526 kcal per 100 g for the energy content of hempseeds.

Mineral content of Hempseeds
The results are presented in Table 6.

Calcium
Callaway (2004) [7] reported a value of 145 mg per 100g for the calcium content of hempseeds which is 33.51 mg lower than the calcium content of hempseeds obtained in the current study. Verma *et al.* (2001) [28] reported the calcium content of hempseeds as 213.30 mg per 100 g on dry weight basis.

Iron
Verma *et al.* (2001) [28] reported the iron content of hempseeds as 62 mg per 100g.

Zinc
Callaway (2004) [7] reported the zinc content of hempseeds as 7 mg per 100g which is slightly less than the value obtained in the current study.

Sodium
Callaway reported the sodium content of hempseeds as 12 mg per 100g which is slightly less than the value obtained in the current study.

Potassium
Callaway (2004) [7] reported the potassium content of hempseeds as 859 mg per 100 g which is 23.19 per cent more than the value obtained in the current study.

Magnesium
Callaway (2004) [7] reported the magnesium content of hempseeds as 483 mg per 100 g which is 54.39 per cent less than the value obtained in the current study.

Table 6: Mineral Composition of Hempseeds on as –is basis and dry weight basis

Minerals (mg per 100g)	Hempseed	
	As - is Basis	Dry weight Basis
Calcium	168.28 ±0.17	178.5±0.18
Iron	20.25±0.23	21.48±0.25
Zinc	6.62±0.27	7.03±0.28
Sodium	12.16±0.98	12.90±1.04
Potassium	787.92±1.96	835.81±2.09
Magnesium	506.60±3.42	537.39±3.62

Values are mean of triplicate observations ± S.D.

Optimization Process of Aonla Products Aonla Fruit Leather
Slab or fruit leather is an important intermediate moisture food product and is traditionally prepared by sun drying of fruit pulp with or without incorporation of varying levels of sugar. This product has domestic as well as export potential. Studies were conducted to develop ideal recipes for the preparation of Aonla leather.
Four samples of Aonla fruit leather were prepared as per the standardized method discussed earlier by adjusting TSS content of pulp- sugar blend to 35%, 40%, 45% and 50% with the incorporation of required amount of sugar. Data on the sensory attributes of Aonla fruit leather in terms of appearance, colour, flavour, texture, taste and mouthfeel and overall acceptability in Table 7.
Results indicate that the recipe with 45% TSS exhibited the highest overall acceptability score of 7.7 and it was followed by recipe with 40% TSS which recorded overall acceptability score of 7.5. The difference between the overall sensory score of these two recipes was however statistically insignificant. The sensory parameters namely appearance, flavour, texture and mouthfeel were not influenced by increasing the concentration of sugar content but it can be observed that there are significant differences in the ratings of colour, taste and overall acceptability of fruit leather samples because of increasing the level of TSS. Results also depicted that elevating the adjustment of TSS of pulp- sugar blend up to 45% improved the ratings of all sensory attributes whereas further increase in the TSS level (50%) was found to produce considerably negative effects on the sensory evaluation parameters. The standardized recipe with 45% TSS due to its highest overall acceptability score was selected as an ideal formulation for the preparation of Aonla fruit leather and for the development of Aonla- hempseeds incorporated fruit leather so as to further improve the acceptability level of the product.

Table 7: Mean Sensory Scores of Aonla Fruit Leather

Recipe No.	Formulation of the Recipes	Sensory Attributes						
	TSS adjustment of pulp – sugar blend	Colour	Flavour	Texture	Taste	Appearance	Mouthfeel	Overall acceptability
1.	35%	7.4	7.4	6.7	6.8	7.4	7.6	6.8
2.	40%	7.5	7.5	7.2	7.8	7.5	7.5	7.5
3.	45%	8.2	7.9	6.8	8	7.5	7.8	7.7
4.	50%	6.8	7.4	6.9	6.6	6.6	7.2	5.8
	SEM	0.28	0.28	0.46	0.22	0.26	0.24	0.25
	CD at 5% level	1.11	ns	Ns	0.66	Ns	Ns	0.74

NS stands for non-significant

Aonla Fruit Jam
Jam is prepared by boiling the fruit pulp with a sufficient quantity of sugar to a reasonably thick consistency, firm enough to hold fruit tissues in firm position (Lal *et al.,* 1985). Two samples of Aonla jam were thus prepared by standardized method described earlier by using different concentrations of sugar i.e. 75% of Aonla pulp and 100% Aonla pulp. The prepared product samples were subjected to the sensory

evaluation so as to select an ideal recipe. Data recorded on the sensory attributes of Aonla fruit leather sample in terms of appearance, colour, flavour, texture, taste, mouthfeel and overall acceptability are furnished in Table 8.

Table 8: Mean Sensory Scores of Aonla Fruit Jam

Recipe No.	Formulation of the Recipes	Sensory Attributes						
	Sugar concentration	Colour	Flavour	Texture	Taste	Appearance	Mouthfeel	Overall acceptability
1.	75% of Alona pulp	8.5	8.0	7.6	8.3	8.2	8.5	8.4
2.	100% of Alona pulp	8.0	7.4	6.7	7.8	6.7	7.1	8.1
	SEM	0.26	0.30	0.33	0.20	0.17	0.20	0.20
	CD at 5% level	0.78	0.89	1.00	0.61	Ns	Ns	0.59

NS stands for non- significant

Recipe no. 1 due to its highest overall acceptability score was selected as an ideal formulation for the preparation of Aonla fruit jam and for the development of Aonla – hempseeds incorporated jam so as to further improve the acceptability level of the product.

Optimization Process of Aonla- Hempseeds Incorporated Products

Aonla- Hempseeds incorporated Fruit Leather

Four samples of fruit leather were prepared as per the method described earlier by incorporating different levels (0, 5,10 and 15%) of hempseeds flour to Aonla pulp, using previously selected ideal formulation for Aonla- hempseeds incorporated fruit leather. These product samples were also subjected to sensory evaluation as per methodology given above.

Table 9: Mean Sensory Scores of Aonla – Hempseed incorporated Fruit Leather

Recipe no.	Formulation of the recipes	Sensory attributes						
		Colour	Flavour	Texture	Taste	Appearance	Mouthfeel	Overall acceptability
1.	125g AP + 0g HS + S adjusted to 45% TSS (90g)	8.5	8.3	7.7	8.3	8.2	8.2	8.3
2.	125g AP + 0g HS + S adjusted to 45% TSS (90g)	7.3	7.7	7.1	7.9	7.4	7.5	7.5
3.	125g AP + 0g HS + S adjusted to 45% TSS (90g)	6.3	6.9	6.4	7.1	6.7	6.7	6.6
4.	125g AP + 0g HS + S adjusted to 45% TSS (90g)	5.9	6.5	6.2	6.4	6.4	6.1	5.8
	SEm CD at 5% level	0.29 0.84	0.26 0.76	0.26 0.75	0.30 0.88	0.28 0.80	0.27 0.78	0.26 0.74

NS stands for non-significant

AP, HS and S stands for Aonla pulp, hempseed flour and sugar respectively.

Results indicate that the recipe no. 2 having 5g of hempseeds flour exhibited the highest overall acceptability score (7.5) and it was followed by recipe no. 3 in which 10g of hempseeds flour was incorporated in the base recipe (45% TSS) whose overall acceptability score was 6.8.

Statistically there were significant differences among the different recipes with regard to sensory scores. Reductions in the ratings of all the sensory attributes due to use of hempseeds flour beyond 5g level might be ascribed to the colour and the gritty nature contributed to the Aonla fruit leather by the hempseeds. Therefore, recipe no. 2 due to its highest overall acceptability score was selected as an ideal formulation for the preparation of Aonla- hempseeds incorporated fruit leather.

Aonla – Hempseeds incorporated Jam

Two samples of fruit leather were prepared as per the method described earlier by incorporating different levels (0, 5, 10 and 15g) of hempseeds flour to Aonla pulp, using previously selected ideal formulation as the basic recipe so as to develop an ideal formulation for Aonla- hempseeds incorporated jam. These product samples were also subjected to sensory evaluation as per the methodology discussed earlier.

Table 10: Mean Sensory Scores of Aonla- Hempseed Incorporated Jam

Recipe no.	Formulation of the recipes	Sensory attributes						
		Colour	Flavour	Texture	Taste	Appearance	Mouthfeel	Overall acceptability
1.	350g AP + 0g HS + S conc. 75% (270g)	8.5	8.7	8.1	8.6	8.7	8.4	8.8
2.	350g AP + 5g HS + S conc. 75% TSS (270g)	8.0	8.1	8.0	8.0	8.3	8.3	7.1
3.	350g AP + 10g HS + S conc. 75% TSS (270g)	8.2	7.9	7.9	7.6	8.0	8.1	7.8
4.	350g AP + 15g HS + S conc. 75% TSS (270g)	7.7	6.8	7.6	7.9	7.9	8.0	7.0
	SEm CD at 5% level	0.29ns	0.23-0.66	0.25ns	0.23-0.67	0.20-0.58	0.24ns	0.22-0.64

NS stands for non-significant.

AP, HS and S stand for Aonla pulp, hempseed flour and sugar respectively.

Results indicate that the recipe with 5 g of hempseeds flour exhibited the highest overall acceptability score (8.1) and it was followed by another recipe in which 10g of hempseeds flour was incorporated in the base recipe (75% sugar of Aonla pulp) whose overall acceptability score was 7.8. Statistically, there were significant differences among the different recipes with regard to sensory scores.

Sensory Evaluation of formulated products Sensory Evaluation of Aonla- Hempseeds Incorporated Fruit Leather Using Score Card Method

Data recorded on the sensory attributes of these Aonla-hempseeds incorporated fruit leather samples in terms of appearance, colour, flavour, texture, taste, mouthfeel and overall acceptability presented in Table 9.

Colour

The control Aonla fruit leather showed the maximum score of 8.5 for the colour and Aonla fruit leather with 1.5g incorporation of hempseeds flour showed the minimum score for the colour of the fruit leather i.e. 5.9. The fruit leather with 5, 10 and 15 g hempseeds flour with 45 per cent TSS showed significant difference in the colour of the Aonla – hempseeds incorporated fruit leather when compared to control.

Appearance

The fruit leather with 10 and 15 g hempseeds flour with 45 per cent TSS showed significant difference in the appearance of the Aonla- hempseeds incorporated fruit leather when compared to control. Fruit leather with 5 g incorporation of hempseeds flour showed non- significant difference in appearance when compared with control Aonla fruit leather.

Texture

The fruit leather with 10 and 15 g hempseeds flour with 45 per cent TSS showed significant difference in the texture of the Aonla- hempseeds incorporated fruit leather when compared to control. Fruit leather with 5g incorporation of hempseeds flour showed non- significant difference in texture when compared with control Aonla fruit leather.

Taste

The results revealed that the sensory scores for the taste of the Aonla fruit leather with different levels of incorporation of hempseeds flour decreased from 8.3 to 6.4 as the level of hempseeds flour increased from 0- 15g. The control Aonla fruit leather showed the maximum score of 8.3 for the taste and Aonla fruit leather with 15g incorporation of hempseeds flour showed the minimum score for the taste of fruit leather i.e. 6.4. Fruit leather with 5g incorporation of hempseeds flour showed non-significant difference in taste when compared with control Aonla fruit leather.

Flavour

The fruit leather with 10 and 15g hempseeds flour with 45 per cent TSS showed significant difference in the flavour of the Aonla- hempseeds incorporated fruit leather when compared to control. Fruit leather with 5g incorporation of hempseeds flour showed non- significant difference in flavour when compared with control Aonla fruit leather.

Mouthfeel

The fruit leather with 10 and 15g hempseeds flour with 45 per cent TSS showed significant difference in the mouthfeel of the Aonla- hempseeds incorporated fruit leather when compared to control. Fruit leather with 5g hempseeds flour added, showed non- significant difference in mouthfeel when compared with control Aonla fruit leather.

Overall Acceptability

The fruit leather with 5, 10 and 15g hempseeds flour with 45 per cent TSS showed significant difference in the overall acceptability of the Aonla- hempseeds incorporated fruit leather when compared to control.

Sensory Evaluation of Aonla- Hempseeds incorporated Jam using Score Card Method

Data recorded on the sensory attributes of these Aonla-hempseeds incorporated jam samples in terms of appearance, colour, flavour, texture, taste, mouthfeel and overall acceptability are furnished in Table 10.

Colour

Jam with 5 and 10g incorporation of hempseeds flour showed non- significant difference in colour when compared with control Aonla jam.

Appearance

The readings revealed that the sensory scores for the appearance of the Aonla jam with different levels of incorporation of hempseeds flour decreased from 8.7 to 7.9 as the level of hempseeds flour increased from 0-15g.The control Aonla jam showed the maximum score of 8.7 for the appearance and Aonla jam with 15g incorporation of hempseeds flour showed the minimum score for the appearance of the jam i.e. 7.9.

Taste

Fruit leather with 5g incorporation of hempseeds flour showed non- significant difference in taste when compared with control Alona jam.

Flavour

Fruit leather with 5g incorporation of hempseeds flour showed non- significant difference in flavour when compared with control Alona jam.

Mouthfeel

The control Aonla jam showed the maximum score of 8.4 for the mouthfeel and Aonla jam with 15g incorporation of hempseeds flour showed the minimum score for the mouthfeel of the jam i.e. 8.The jam with 5, 10 and 15 g hempseeds flour with 75 per cent sugar concentration showed non- significant difference in the mouthfeel of the Aonla- hempseeds incorporated jam when compared to control.

Overall Acceptability

The control Aonla jam showed the maximum score of 8.8 for the overall acceptability and the Aonla jam with 15g incorporation of hempseeds flour showed the minimum score for the overall acceptability of the fruit leather i.e. 7.

Chemical Characteristics of Aonla- Hempseeds incorporated Products

The Aonla fruit leather and Aonla jam prepared from standardized recipes with or without incorporation of hempseeds were subjected to chemical analysis.

Fruit Leather

Data recorded on the chemical characteristics and mineral content of Aonla fruit leather and Aonla- hempseeds incorporated fruit leather are presented in Tables 11 and 12 and Figures 4, 5 and 6.Data pertaining to chemical characteristics of Aonla fruit leather and Aonla hempseeds incorporated fruit leather showed that in general these contain almost similar levels of pH, TSS, reducing sugars, tannins, pectin and ascorbic acid content.

There is only a slight increase in the protein content of the fruit leather after the incorporation of 5g hempseeds. This can be attributed to low level of incorporation of hempseeds. However there is only a slight increase in the value s of zinc, sodium and iron content.

Table 11: Chemical Characteristics of Aonla Fruit Leather and Aonla- Hempseeds incorporated Fruit leather

Characteristics	Aonla Fruit Leather	Aonla – Hempseeds incorporated Fruit leathe
Moisture (%)	21.86±0.04	32.01±0.04
Crude Protein (%)	0.36± 0.03	1.60±0.01
pH	3.02±0.00	2.07±0.01
Titrable Acidity (% as citric acid)	71.28±0.49	68.45±0.07
Total Soluble Solids (º Brix)	0.79±0.04	0.60±0.02
Reducing Sugars (%)	21.19±0.59	19.42±0.17
Total Sugars (%)	40.73±0.73	34.92±2.53
Tannins (mg/100g)	2.67±0.36	2.02±0.02
Pectin (%)	1.28±0.07	1.00±0.02
Ascorbic Acid (mg/100g)	109.74±1.08	107.62±0.17

Values are mean of triplicate observations ± S.D.

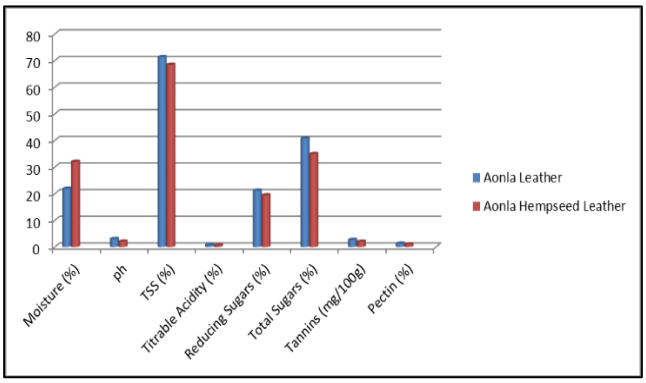

Fig 4: Chemical Characteristics of Aonla Fruit Leather and Aonla-Hempseed Incorporated Fruit Leather

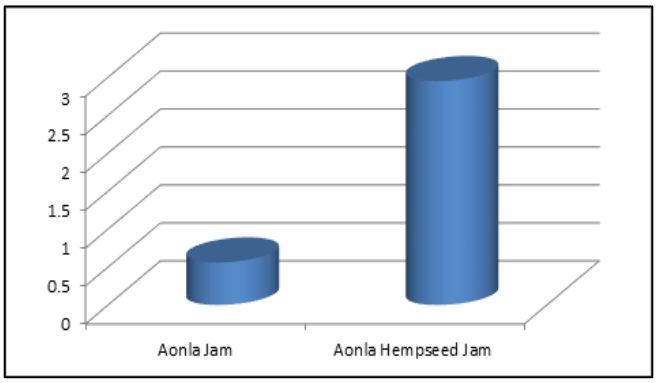

Fig 5: Crude Protein Content of Aonla Fruit Leather and Aonla-Hempseed Incorporated Fruit Leather in per cent

Table 12: Mineral Composition of Aonla Fruit Leather and Aonla- Hempseeds Incorporated Fruit Leather

Characteristics	Aonla Fruit Leather	Aonla- Hempseeds Incorporated Fruit Leather
Calcium	42.28±1.74	60.89±0.29
Iron	0.85±0.04	3.01±0.13
Zinc	0.97±0.03	1.44±0.0
Sodium	5.78±0.03	6.70±0.27
Potassium	222.46±0.96	270.85±0.61
Magnesium	5.86±0.31	42.54±0.27

Values are mean of triplicate observations ± S.D.

Jam

Data recorded on the chemical characteristics and mineral content of Aonla jam and Aonla- hempseeds incorporated jam are presented in Tables 12 and 13 and Figures 7, 8 and 9. From the results it can be revealed that the Aonla- hempseeds incorporated jam showed a considerable increase in its mineral content with 5g incorporation of hemp seeds. The magnesium content of jam increased by 30 per cent with the incorporation of hempseeds whereas there is 50 per cent increase in the potassium content with the incorporation of 5 g of hempseeds.

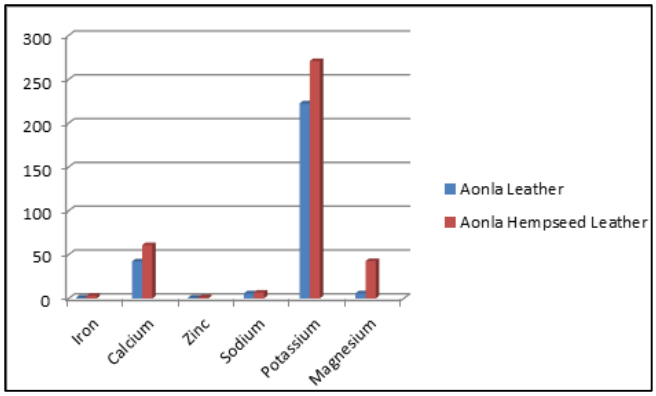

Fig 6. Mineral Content of Aonla Fruit Leather and Aonla – Hempseed Incorporated Fruit Leather in mg per 100g

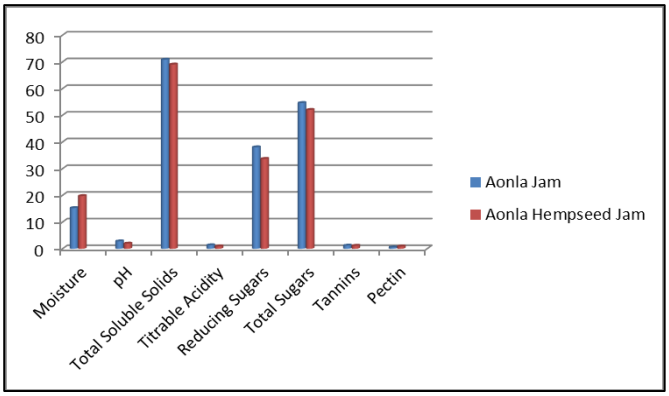

Fig 7. Chemical Characteristics of Aonla Jam and Aonla- Hempseed Incorporated Jam

Table 12: Chemical Characteristics of Aonla Jam and Aonla – Hempseeds Incorporated Jam

Characteristics	Aonla Jam	Aonla – Hempseeds Incorporated Jam
Moisture (%)	15.25±0.04	19.75±0.37
Crude Protein (%)	0.56±0.03	2.95±0.06
pH	2.80±0.0	1.95±0.06
Titrable Acidity (% as citric acid)	70.85±0.49	69.03±0.03
Total Soluble Solids (ºBrix)	1.33±0.04	0.91±0.0
Reducing Sugars (%)	38.03±1.85	33.68±0.49
Total Sugars (%)	54.61±1.63	52.02±0.04
Tannins (mg/100g)	1.20±0.03	1.13±0.04
Pectin (%)	0.88±0.03	0.87±0.01
Ascorbic Acid (mg/100g)	62.15±2.08	61.93±0.23

Values are mean of triplicate observations ± S.D.

Table 13: Mineral Composition of Aonla Jam and Aonla- Hempseeds Incorporated Jam

Characteristics	Aonla Jam	Aonla-Hempseeds Incorporated Jam
Calcium	41.44±1.2	52.46±0.13
Iron	0.64±0.02	2.82±0.15
Zinc	0.88±0.02	2.28±0.03
Sodium	3.83±0.10	7.52±0.10
Potassium	216.86±1.60	267.08±2.20
Magnesium	5.70±0.28	35.99±0.46

Values are mean of triplicate observations ± S.D.

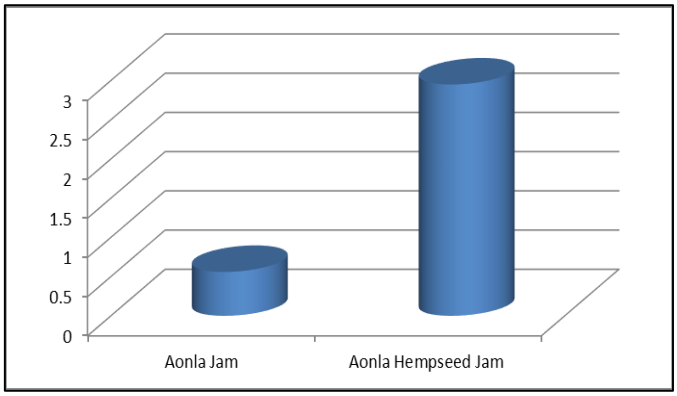

Fig 8: Crude protein content of Aonla jam and Aonla –hempseed incorporated jam (per cent).

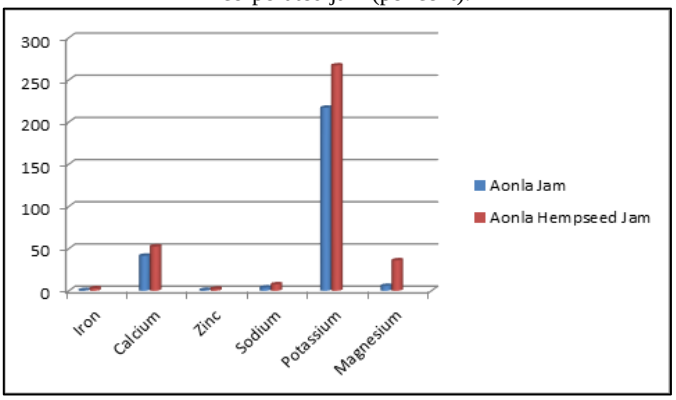

Table 9: Mineral Content of Aonla Jam and Aonla- hempseed Incorporated Jam in mg per 100 g.

Results and Conclusions

Thus from the present study it can be concluded that the Aonla products namely fruit leather and jam can be made successfully with the incorporation of hempseeds. Being an acidic and astringent fruit, several value added products can be developed from Aonla. Further it is recommended that development of several value added products of hempseeds like chips, pretzels, snack bars, biscuits, pasta, drinks and beverages can be pilot tested with.

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