Organoleptic Evaluation of Calcium and Protein-rich snacks Developed from *Macrotyloma uniflorum*, *Papaver somniferum* and *Sesamum indicum* using TOPSIS

Shelly Garg*, Dr Luxita Sharma

Department of Dietetics & Applied Nutrition, Amity Medical School, Amity University Haryana, India122412.

ABSTRACT

*Horse gramis used as a remedy for kidney stones, bronchial asthma, bronchitis, leukoderma, urinary discharges, heart diseases and piles. Besides, it also possesses anti-diabetic, anti-ulcer interest and helps in nutritional management of obesity due to the presence of beneficial bioactive compounds.The opium poppy (Papaver somniferum) produces a variety of extensively used medicinal alkaloids like morphine, codeine, thebain and porphyroxine which might be the maximum important element of this plant. It is used as analgesic, narcotic, sedative, stimulant in addition to nutritive, and so forth. It is also beneficial in headache, cough, insomnia, cardiac asthma, and biliary colic.Sesame seeds likewise contain two exceptional substances: sesamin and sesamolin known to have a cholesterol bringing impact in people and down to forestall hypertension. Cephalin, a phospholipid from sesame seed has been accounted for to have haemostatics action.*The product is made by using different methods including *soaking*, drying, grinding, *roasting* and *microwave baking. Overall, 4 samples have been advanced to determine the most ideal food product thru sensory evaluation by using different individuals.Statistical tests like MAHP and TOPSIS were used to rank the samples.* Sample D shows both highest ranking in TOPSIS as well as high hedonic rating, among all four samples containing 40% horse gram, 35% poppys seeds and 25% sesame seeds. The aim of the product developed is to prevent and control *Calcium* deficiency. Apart from this, the product is calorie dense; rich in protein, omega fatty acids and antioxidant, which are required in building immunity.

Keywords

Calcium; Nutrition; Organoleptic; Protein; Sesame; TOPSIS

1. INTRODUCTION

This study was done to develop a food product by using horse gram, poppy seeds, and sesame seeds as the main raw ingredients and apart from these salt, black pepper and garlic paste were used to enhance its flavour and add a little spice to the snack.

1.1 Horse Gram *(Macrotyloma uniflorum)*

Horsegram is of family Fabaceae, it is legume grain which is capable of exceptional dietary and remedial residences with higher climate abilities to change itself in rough environmental situations (Kumar, 2006). It also has carbohydrates which has not easily digestible content which is result in lesser quantity of glucose in blood movement which result in nutritional control of diabetes (Samanta et al., 2011).

Horsegram seeds protein provides higher content of lysine material in comparison to chickpea and pigeon pea, and it makes it complete meal with cereal for fat loss (Venkatesha, 1999). Horsegram flour has excessive amount of dietary fibre which has tremendous healtheffects on colon body structure and intestine, other than therapeutic function and homoeostatic in nutrition(Sreerama et al., 2012).

Sreerama et al., 2012 did a comparison analysis with cowpea and kulath flour and stated the presence of various toxic articles like, polyphenols and trypsin inhibitors more in kulath flour. The phenols present in kulath flour was more and this is indeed responsible agent for forming bonds with protein; complexes which stop assimilation of proteins when they are in unbound state and reducing the degradation of protein with protein degrading enzymes. The iron content of this plant is known to be of high in amounts, but their assimilation is almost made impossible due to tannins and oxalates. Studies have shown that some of the toxic substances are known to behave like scavengers for unbound electron species. Most common of them is phytic acid, which now is flourishing as cancer killing and low glycemic inherent property, this indeed depends on people to people; if they would want to remove the phytic acid content or utilize the pulse with it. (Ranasinghe & Ediriweera, 2017)

1.2 Poppy Seeds*(Papaver somniferum)*

Poppy seeds contain copper, iron, potassium, zinc, manganese and magnesium. Poppy seeds are rich in iron and zinc which could help enhance your immune machine. Beside this those are rich supply of fibre poppy seeds can assist along with your digestion and simplicity or prevent constipation. Poppies content for phosphorus, iron, magnesium, calcium and potassium were 4000mg/kg, 7mg/kg, 280mg/kg, 690mg/kg and 746mg/kg respectively, which was obtained through optical spectrometry.(Kumaravel & Alagusundaram, 2014).

Sproll et al., 2006 studied various ways of reducing the morphine or its complete elimination from the seeds of poppy and came up with conclusions like grinding of these seeds reduces the levels of morphine and storing them in their grinded state does not affect any changes on the levels of morphine; remains same. Another method of reducing morphine was by washing it with hot water would eliminate morphine up to 70%. Basic process of reducing the morphine content is washing, drying and grinding, this in turn will help organoleptic properties of the finished product. (Sproll et al., 2006) To reduce toxins including codeine, thebaine and narcotine same processes of washing, drying and grinding are applied, which is tested by the HPLC method showed great reduction of up to 0.5% in each toxin level. Processed poppy was further incorporated to make food product which were more acceptable, product made by bakery at 200°C further reduced the content of these toxins. (Sharma et al., 2015)

1.3 Sesame Seeds*(Sesamum indicum L.)*

The composition of sesame possesses lipid contents 48gms, carbohydrates 25.7gms, proteins 17gms, fibre 14gms and ash 6gms approximately with appreciate to 100gm of seeds. Sesame seeds have abundance of various minerals inclusive of Calcium, Phosphorous, Magnesium, and Potassium in massive quantities.Also,it has nutrients namely Niacin, Thiamine, Riboflavin and B-6 (USDA Nutrient Database, 2015).

Sesame oil is referred to as a queen of oils. Sesame has distinctive therapeutic effect beneficial for mankind (Prasad, MN et al., 2012). Sesame oil carries wide medical and pharmaceutical properties. It has been found that sesame protects the liver from oxidative

damage. After exposure to solar or wind, sesame oil is used to calm the burned. Sesame oil is also used as hair oil which nourishes the dry scalp dandruff and additionally kill the microbes which is responsible for dandruff. (Asghar et al., 2014)

Sesame oil carries poly unsaturated fatty acids (PUFA), vitamin E and sesamin which greatly lowers the blood pressure as compared to the blood pressure lowering drugs. Consumption of sesamin considerably helps against plague formed in aorta and advanced mesenteric artery. In renal damage sesamin is likewise extremely helpful. The destruction occurs completely of the tunica intima which was previously thickened and starting the degenerative property of the arterial wall which consists of fibrinoid that is responsible for kidney damage (Prasad, MN et al., 2012).

The inclusions of foods like sesame seeds, fenugreek seeds, and datein the diet during the pre-natal stagesincreased the milk content produced by the women (Kanwar & Sharma 2011).

1.4 Aims and Objectives

- To develop a nutritionally adequate food product from available food sourcesloaded with carbohydrates, proteins, fibers,fats,energy, and Calcium.
- To study organoleptic properties of the food product by developing variations.
- To calculate the dietary value of the food product by calculating calories, proteins, fat, fibres and calcium.
- To rank developed samples using various statistical methods like mean, standard deviation and TOPSIS.

2. MATERIALS AND METHODS

Horse gram, poppy seeds and sesame seeds were brought from local markets of Gurgaon, Haryana. During the purchase all the items were selected for the high quality and in sufficient quantity, in order to make 4 samples. Weighing of eachraw material was done separately according to individual sample requirements.

2.1 Preparation of snack sticks

Soaking: Wash Horse gram and poppy seeds thoroughly. Horse gram was soaked for 8 hours, this was done in order to remove the toxins like trypsin inhibitors and increase nutrients like protein and ascorbic acid. Poppy seeds were washed with warm water twice and then were soaked in warm water overnight. Washing and soaking with warm water reduces the morphine content in the seeds of poppy.

Sun- Drying: Horse gram was sun-dried for 4 continuous days with six hours exposure to sun daily.

Grinding: Dried horse gram was grinded to form its flour and soaked poppy seeds were grinded with a little amount of water to form a paste. Grinding the poppy seeds reduces its morphine content up to 70%. The product obtained after grinding are palatable and easily digestible, with also saving time during cooking. Both these ingredients were grinded separately.

Roasting: A pan is heated on medium flame and the sesame seeds were added and flame was turned to low, following the roasting process for 3-6 minutes; observing a slight change in colour of seeds and a pleasant aroma.

Dough formation: All the ingredients were mixed along with required amount of salt, black pepper and garlic paste along with some amount of water to bring the consistency to a semi-solid state. The dough was kept aside for 5 minutes and was rolled to form sticks.

Baking: The microwave was preheated at 180°C in convection mode for 10 minutes. A baking tray was greased with some drops of oil and the rolled sticks were placed on the baking tray, the tray was placed in the microwave above the low rack stand and the mode of the microwave was set to convection and temperature set at 180°C, with 25 minutes of time setting.

2.2 Sample Variation

Variation was done in the quantity of horse gram flour, poppy seeds paste, and roasted sesame seeds. In total of four samples were made from these basic ingredients.

Sample A- This sample consisted of 50g of horse gram flour, 30g of poppy seed paste and 20g of roasted sesame seeds.

Sample B- This sample consisted of 60g of horse gram flour, 25g of poppy seed paste and 15g of roasted sesame seeds.

Sample C- This sample consisted of 70g of horse gram flour, 20g of poppy seed paste and 10g of roasted sesame seed.

Sample D- This sample consisted of 40g of horse gram flour, 35g of poppy seed paste and 25g of roasted sesame seeds.
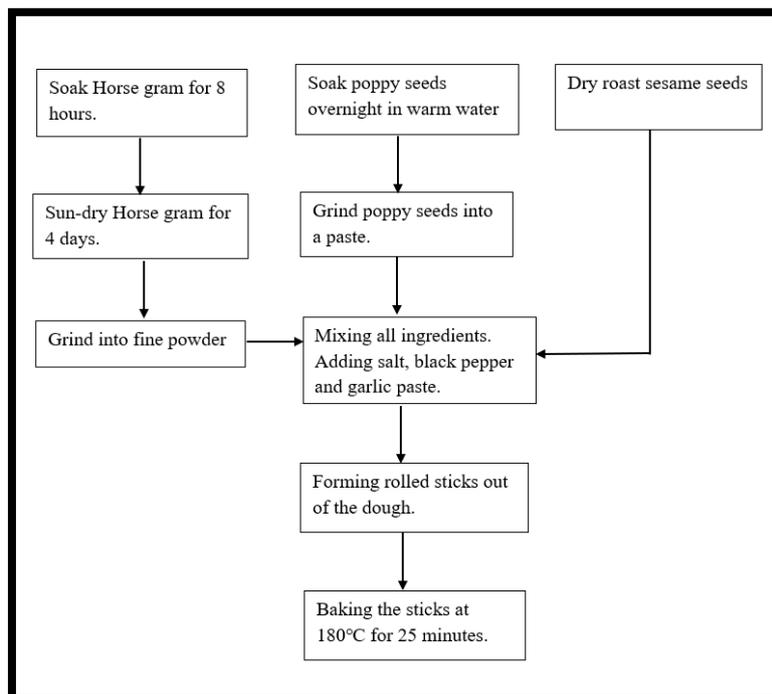
Ingredient	Sample A (g)	Sample B (g)	Sample C (g)	Sample D (g)
Horse gram	50	60	70	40
Poppy seed	30	25	20	35
Roasted sesame	20	15	20	25

Table1: Sample variation according to percentage and amount.

These ratios were considered to make each sample and later were taken for the sensory evaluation, with the help of using the 9-point hedonic rating scale.

Image 1: Sticks of all samples

Figure 1: Schematic representation of stick preparation

2.3 Sensory Evaluation

9- scale Hedonic test was used to test the sensory properties of the developed product. For each variable, 15 hedonic tests were performed by a panel of judges. Each member of the panel was presented with 4 variants and told to evaluate the sample based on various characteristics that were of taste, colour, consistency, texture, adherence and overall acceptance (Srilakshmi, 2012). The results were calculated and analysed by calculating their mean and standard deviation for individual as well as overall samples.

2.4 Nutritional Analysis-

For every food we consume, nutritional composition of the food should be known. AOAC 2005 method was used for the nutritional analysis of the product. Carbohydrate, protein, fats, energy content, moisture and ash were calculated for 100g of the sample.

Carbohydrate estimation was done using the Antrone method, Micro-Kjeldahl method was used for the estimation of proteins, while Soxhlet apparatus method was used for the estimation of fats in the product.

Energy- Energy was calculated by multiplying proteins and carbohydrates by four and multiplying fats by nine and adding up the values of three.

Moisture content- calculations were done according to the AOAC's oven method. Weigh 5g of sample in a clean and dried dish. Place the sample in the pre-heated oven (maintained at 130°C) for 2 hours. Measure the weight at an interval of 30 minutes. Weight till three constant reading is recorded.

Moisture content (%) = $(W_1-W_2)*100/W_1-W$

Where, W_1= Weight of dish with the material before drying (g)

W_2= Weight of dish with the material after drying (g)

W= Weight of empty dish (g)

Ash- take 10g of sample in silica crucible. Heat the crucible in muffle furnace at 600°C for 4-5 hours. Continue the ignition process till a grey ash is obtained. Cool the ash in desiccator and weigh. Repeat the process for another half hour and note the reading. Repeat till three constant reading is recorded.

Ash (%)= Weight of ash*100/ Weight of sample taken

Dietary fibre was calculated using Enzymatic-Gravimetric method. Flame atomic absorption spectrometry is used to calculate amount of calcium present in the sample.

3. RESULTS

3.1 Calculation of weights by MAHP (Means of Analytical Hierarchy Process)

MAHP is used for the selection of best product/option from a list of various available options. Pair-wise comparison scale was used for the ranking procedure (Forman et al., 2001).

3.1.1 Analytical Hierarchy Process technique-

Letting the set of the criteria be A= {A_j}, where j= 1, 2, 3 …... n.

The pair-wise comparison of a matrix Z of 'n' number of criteria can be drawn as (n X n) matrix. Each element in (n X n) matrix is 'ij', where i, j= 1, 2, 3 ……. n.

A_1	1	a_{12}	a_{13} …………	a_{1n}
A_2	a_{21}	1	a_{23}	a_{2n}
A_3	a_{31}	a_{32}	1 ……………	a_{3n}
.	.	.	. ……………	.
A_n	a_{n1}	a_{n2}	a_{n3} …………..	1

Table 2: Pair-wise comparison matrix for n number of criteria

Step 1: The first step is to draw a '4*4' matrix for four different samples and calculations were done.

	A	B	C	D	4th root	PV
A	1	0.5	0.33	0.25	0.4506	0.0951
B	2	1	0.5	0.33	0.7579	0.1599
C	3	2	1	0.5	1.3160	0.2777
D	4	3	2	1	2.2133	0.4671

Sum	10	6.5	3.83	2.08	4.7380
Sum PV	0.9511	1.0397	1.0638	0.9716	4.0264

Table 3: AHP calculation matrix of the present study

Step 2: After drawing the matrix, calculation of 4th root was done.

4th root for A= $(1* 0.5* 0.33* 0.25)^{1/4}$; B= $(2* 1* 0.5* 0.33)^{1/4}$; C= $(3* 2* 1* 0.5)^{1/4}$; D= $(4* 3* 2* 1)^{1/4}$

Step 3: After calculating individual 4th root, sum of all the 4th roots were done, which was found to be 4.738.

Step 4: Then, the calculation of PV for each group was done. For calculation of PV, divide 4th root for each sample by the sum of 4th root. Repeat the steps for all the four variables.

Step 5: Then the calculation of sum PV for each variable was done.

Sum PV for A= 0.0951* 10 = 0.9511; For B= 0.1599* 6.5 = 1.0397; For C= 0.2777* 3.83 = 1.0638; For D= 0.4671* 2.08 = 0.9716

Step 6: Then the calculation of Total for Sum PV= $\lambda_{(max)}$ {Lambda- max} was done.

$\lambda_{(max)}= \sum(PV (A,B,C,D)) = 4.0264$

Step 7: Then the next step is to calculate CI value (Consistency Index). It is calculated using formula given below-

CI= $(\lambda_{(max)} - n)/ (n-1)$,

Where n= number of systems/ variables being compared

CI (Consistency Index) = 4.0264-4/ 3= 0.0088

Step 7: Then finally, the CR (Consistency Ratio) value was calculated by dividing CI (Consistency Index) by RI value,

Where, RI is Random Index. Values of RI are given in table 3.

N	1	2	3	4	5	6	7	8	9
RI	0.000	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Table 4: Random Consistency Index

In our study, total 6 criteria were compared, so, n= 6. RI for 6 is used to calculate CR value.

CR= 0.0088/ 1.24= 0.0071

The CR is the indicator of consistency of the various samples. A consistency ratio of less than 0.1 is acceptable. A matrix is said to be consistent and acceptable if the consistency ratio is less than 0.1. if the Consistency ratio comes more than 0.1, then the sample is corrected using various correction measures.

Calculated Consistency Ratio of the study is 0.0071, which is less than 0.1, so our pair-wise comparison test was foundto be consistent, and no corrective actions were required for the comparison.

3.2 TOPSIS for Ranking the Samples

Mean scores for all the 6 attributes for each sample were used in the TOPSIS method, along with the calculated weights value from AHP method. 7 different attributes used were colour, aroma, texture, taste, chewiness, consistency and overall acceptability.

	Sample A	**Sample B**	**Sample C**	**Sample D**
Taste	5.8±0.560	7.73±0.798	7.2±0.861	8.13± 0.833

Color	5.93±0.961	7.0± 0.703	7.4±0.910	7.86±0.639
Texture	6.06±1.032	7.0± 0.703	7.26± 0.883	8.0±0.925
Consistency	6.0±0.845	7.53±0.639	7.13±0.915	8.06±0.883
Crispiness	5.93±0.961	6.8±0.941	7.2±0.941	7.93±0.703
Overall Acceptability	5.93±0.883[d]	7.13±0.743[c]	7.53±0.833[b]	8.13±0.833[a]
Calculated Weights	**0.0951**	**0.1599**	**0.2777**	**0.4671**

Table 5: Mean scores obtained from sensory evaluation and calculated weights from AHP technique.

Test results of 9-scale Hedonic rating were then analysed, mean and standard deviation was calculated. All the four samples were ranked using TOPSIS.

m= varieties of sample= 4; n= number of attributes= 6

	A	**B**	**C**	**D**
Taste	0.3984	0.4392	0.4033	0.4139
Colour	0.4074	0.3977	0.4145	0.4001
Texture	0.4163	0.3977	0.4066	0.4072
Consistency	0.4122	0.3977	0.3994	0.4103
Crispiness	0.4074	0.4278	0.4033	0.4037
Overall	0.4074	0.3864	0.4218	0.4139

Table 6: Calculation of $(\Sigma x^2_{ij})^{1/2}$ for each row

Step 1: Calculation of r_{ij}

To calculate r_{ij} for each attribute, divide the mean score for every attribute by $(\Sigma x^2_{ij})^{1/2}$ for every sample.

	A	**B**	**C**	**D**	**V+**	**V-**
Taste	0.0378	0.0702	0.1120	0.1933	0.1933	0.0378
Colour	0.0387	0.0636	0.1151	0.1869	0.1869	0.0387
Texture	0.0395	0.0636	0.1129	0.1902	0.1902	0.0395
Consistency	0.0392	0.0636	0.1109	0.1916	0.1916	0.0392
Crispiness	0.0387	0.0684	0.1120	0.1885	0.1885	0.0387
Overall	0.0387	0.0617	0.1171	0.1933	0.1933	0.0387

Table 7: Positive and Negative Ideal Situation. Where, V+ is Positive Ideal Solution and V- is the Negative Ideal Solution.

Step 2: Then the Positive and Negative Ideal Solutions are determined.

Positive Ideal Solution is the highest value for each attribute, whilethe lowest value for each attribute is considered as the Negative Ideal Solution.

Step 3: Then theseparation from Positive Ideal Solution as well as Negative Ideal Solution is determined-

$Si = [S(v_j* - v_{ij}*)^2]^{1/2}$

Si+ and Si- negative values were calculated for all the samples.

Si+ is the Separation from Positive Ideal Solution, While Si- is the Separation from Negative Ideal Solution.

**Step 4:** Then the relative closeness to the ideal solution was calculated using the formula-

$Ci = (Si-) / \{(Si+) + (Si-)\}$

3.3 Ranking

The best sample was found to be Sample D, followed by Sample C and Sample B. Sample A was ranked last.Sample D was the most accepted, while sample A was the least accepted sample.

	A	B	C	D
Si+	0.3720	0.3074	0.1895	0
Si-	0	0.0651	0.1826	0.3720
Ci	0	0.1748	0.4906	1
Rank	4	3	2	1

Table 8: Si values and Ci values for each sample. Ranks of different samples.
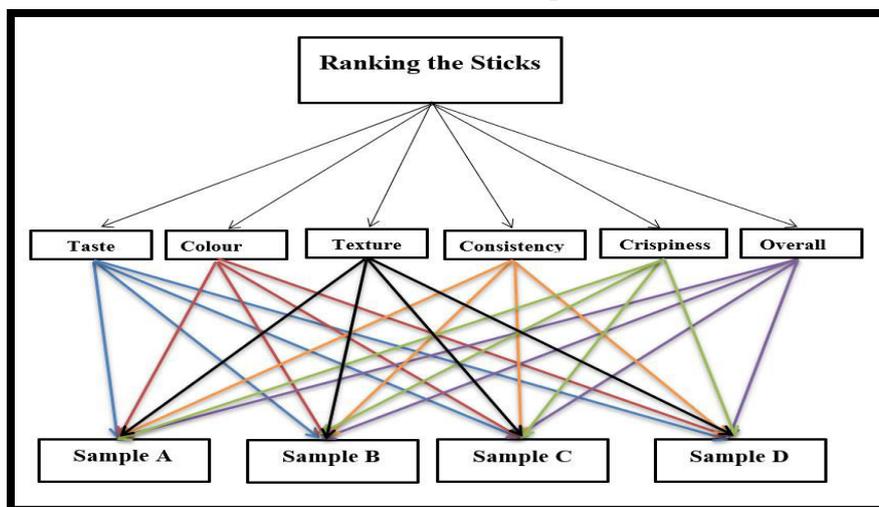
Figure 2: Hierarchical Structure

3.4 Nutritional Analysis-

Sample D was subjected to nutritional analysis. It was done using AOAC method, 2005. Results were obtained for per 100g of the sample.

NUTRIENT	AMOUNT (per 100g)
Energy	1713.9 KJ (409.63 Kcal)
Carbohydrates	29.91 g
Proteins	21.21 g
Fats	21.63 g
Fiber	16.72 g
Moisture	3.62 g
Ash	4.43 g
Calcium	908.55 mg

Table 9: Results of nutritional analysis per 100g of sample D

4. CONCLUSION

The aim of the project was to develop a food product that is a good source of nutrients, evaluate its organoleptic values through a 9- point rating scale and rank it using TOPSIS. While making the product, it was kept in mind that the product should be easy to carry & store, ready to eat and have a good shelf life. The product was made focusing the current health issues prevailing in our societies.

The raw materials medicinal uses were studied and incorporated into developing this product so that it can be used in treating metabolic and deficiency disorders. Horse gram is found to be a good source of protein, calcium and dietary fibres, Poppy seeds are known for their calcium content, while the sesame seeds are rich in calcium, unsaturated fatty acids and iron. These ingredients were chosen in making the product by studying their therapeutic benefits, which indeed will benefit the people with deficiencies. Product made is rich in calcium, iron, proteins, fibre and healthy fats.

From this study it can be concluded that the product can be consumed by people suffering from calcium deficiency, diabetes, constipation, high lipid profile and cardiac diseases. The product made is gluten free, lactose free, soy free and a vegan product. The product can be taken while snacking, with beverages and soups. The sticks can be consumed by people of any age and gender. This product can be used in treating multiple diseases, because it is nutrient dense and can help maintain a good health.

5. Declaration of Interest-

Authors declare no conflict of interest.

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