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ASSESSMENT OF ORGANOLEPTIC AND NOURISHING PROPERTIES OF NACHOS DEVELOPED FROM *NELUMBO NUCIFERA* USING TOPSIS

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ABSTRACT

A study was carried out on the functional and organoleptic properties of nachos made from lotus stem. A total of five samples of nachos having lotus stem were taken, with lotus stem incorporated in different quantities; precisely 10g, 20g, 30g, 40g and 50g. Sensory analysis using the hedonic rating scale was done to evaluate the industrial acceptance of the nachos. It was revealed by the results of sensory analysis that all samples had a good quality overall and had higher positive scores for crackling, aroma and color; using the quantitative descriptive analysis method. Further the developed nachos were analysed using MAHP (Mean Analytical Hierarchical Process) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution). All the samples were then subjected to proximate analysis, and it was found that all the developed samples were rich in fiber, particularly sample H5s. Also, the developed samples of nachos were a good source of protein and energy.

Keywords: Nachos, lotus stem, organoleptic, hedonic, nutrients, TOPSIS

INTRODUCTION

The focus of this work lies on the development and lab analysis of a supplementary food that has been developed from a variation of lotus stem. Five different samples of the product were made, with each sample having carried proportions of the ingredients. Sensory evaluation was carried out in order to select the well-accepted sample of the five. The bash involves preparation of lotus stem incorporated nachos. This

incorporation provides nachos loaded with more dietary fibre, calcium, iron and vitamin B. These nachos become nutritious and healthy snacks, and will be helpful in bridging the gap between nutritional deficiencies and health status.

REVIEW

LOTUS STEM

Lotus stem, or *Nulembo nucifera Gaertn.,* is an aquatic vegetable found in the Asian continent. It contains good amount of proteins, amino acids, starch, dietary fiber as well as Vitamin C, Vitamin B2 and Vitamin B1. It has a distinctive aroma and a crispy and hard texture, accounting for it being a favorable crop among Asians **[1]**. Dishes like salads, pickles, confections and stir-fried foods are often made from lotus stem. Lotus stem includes a hefty amount of polyphenolic compounds as well as high antioxidant properties. The antioxidant properties of rhizome extract along with rhizome knot extract of edible lotus were studied and were found that the total phenol content in the extract could be correlated to the antioxidant capacities of the plant, except for hunting for carbon centred radicals **[2]**.

The shelf life of lotus is short and processing significantly degrades the quality, which accounts for the production being limited even after widespread use as a functional and edible food **[3]**. A major problem that is detrimental to storage and processing is browning. Due to polyphenolic compounds, brown pigment is accumulated owing to enzymatic browning. The harvest period, too, is of short duration, which adds to the woes.

Therefore, development of products from lotus stem not only solves these indirect problems, but also leads to economic benefits on a significant scale. Favourable taste and high nutritional composition have brought vegetable juices into the limelight of attention in recent times **[4]**. Presence of minor compounds of great health importance like flavonoids, minerals and xanthophyll is in appreciable amounts **[5]**.

NACHOS

Nachos are a popular dish from Northern Mexico, constituting of heated tortilla chips or totopos along with melted cheese or cheese based sauces. It is generally served as a means of snacking or as an appetizer **[6]**. Other ingredients have found their way to more elaborate versions of the dish, thus making them substantial enough to be counted as a dish of the main course. Accreditation is given to Ignacio “el nacho” Anaya for the creation of the dish, way back in 1943. The original nachos then prepared used fried corn tortilla chips with coverings of melted cheese along with sliced jalapeno peppers **[7]**.

MATERIALS AND METHODS

Preparation of nachos was done using lotus stem powder, corn flour, whole wheat flour, onion and garlic powder. All the raw ingredients were brought from local market of

Gurugram, Haryana. Equipment used during the product development were grinder, rolling pin, microwave, cutter and 120 mesh BS sieve.

Steps involved in the development of LS Nachos-

1. Clean the lotus stem thoroughly and peel them.
2. Cut lotus stem into small pieces and sun dry them for 4 days.
3. Dried lotus stem was then ground into a fine powder using grinder.
4. Sieved the lotus stem powder through 120 mesh US sieve.
5. In a mixing bowl, corn flour, whole wheat flour and lotus stem powder, along with salt, onion, and garlic powder was mixed in the desired ratios of the product to be made.
6. Dough is made using water. Keep the dough aside for 30 minutes.
7. Divide the dough into small portions and roll out each portion into thin tortillas.
8. Cut the tortillas in the shape of nachos using a sharp cutter and prick them using fork.
9. Pre heated the microwave at 180°C for 10 minutes.
10. Place the cut nachos into the pre-heated microwave.
11. Bake the nachos at 150°C for 15-18 minutes.
12. Remove nachos from oven and let it cool.

Table 1: Standardised recipe for Nachos preparation

Ingredients	Amount (g)
Corn flour	50
Whole wheat flour	50
Onion powder	5
Garlic powder	5
Salt	To taste
Red chili powder	To taste
Oil	To brush

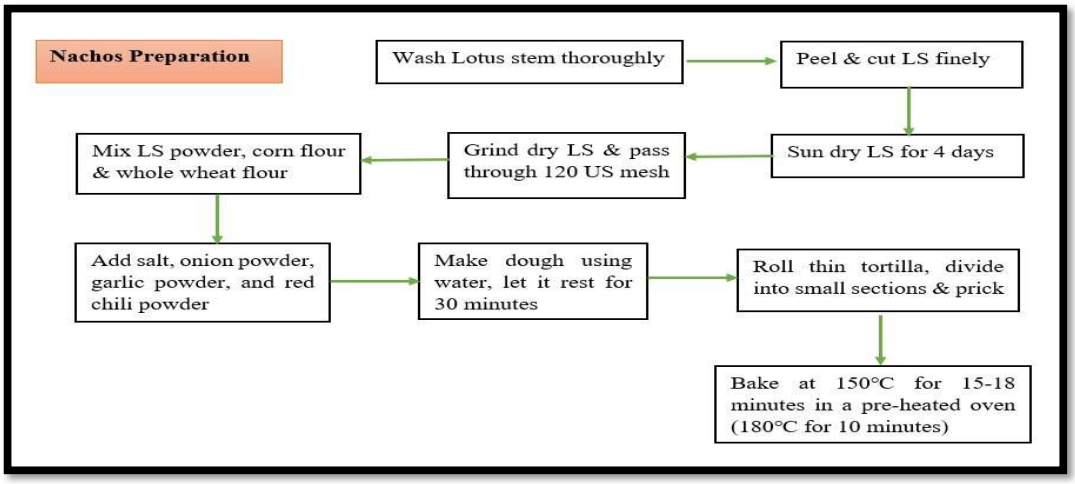

Figure 1: Lotus Stem Nachos Preparation

Sample Variation

Weight of all the ingredients were taken independently in accordance with the individual sample requirement. The weight was measured using electronic balance. 5 samples were made using the variation of lotus stem powder, whole wheat flour and corn flour. Sample 'H1s' constitute 10g lotus stem powder, 'H2s' contains 20g, 'H3s' contains 30g, 'H4s' contains 40g, and 'H5s' contains 50g of powder.

Sample H1s, H2s, H3s, H4s and H5s had 45g, 40g, 35g, 30g, and 25 each of corn flour and whole wheat flour, respectively.

Table 2: Sample variation for the preparation of Nachos

Ingredients	H1s (g)	H2s (g)	H3s (g)	H4s (g)	H5s (g)
Lotus stem powder	10	20	30	40	50
Corn flour	45	40	35	30	25
Whole wheat flour	45	40	35	30	25

Sensory/ Organoleptic Evaluation-

Triangle test, 9 point Hedonic test and Ranking test were performed to check for organoleptic properties. A total of 30 panelists were selected for triangle test, they were given 3 samples of coffee, 2 containing equal amount of sugar and 1 containing less sugar. Individuals who passed triangle test were selected as panelists for 9 point hedonic test and ranking test. Five samples were made and were presented to all the selected panelists individually. They were then asked to rate the products on various parameters like taste, texture, acceptability, crunchiness and overall acceptability.

Statistical analysis- Statistical analysis gives better insight into the approval or rejection of null hypothesis. Mean, and Standard Deviation of the 9 point hedonic tests were calculated and interpreted. With the interpretation of mean and standard deviation scores, most accepted product was selected. Further MAHP and TOPSIS were used to analyse the products on various parameters.

Nutritional Analysis - Nutritional analysis was done by AOAC method 2005. Calories, carbohydrates, protein, fats, fibre, moisture and ash were calculated per 100g of the sample, to find out the effectiveness of the product.

RESULTS

Sensory Evaluation using 9-Scale Hedonic test

The scores of sensory evaluations indicate the Mean range of all attributes studied for LS Nachos, the mean values were ranged between 6.33-8.53 for H1s, H2s, H3s, H4s, and H5s.

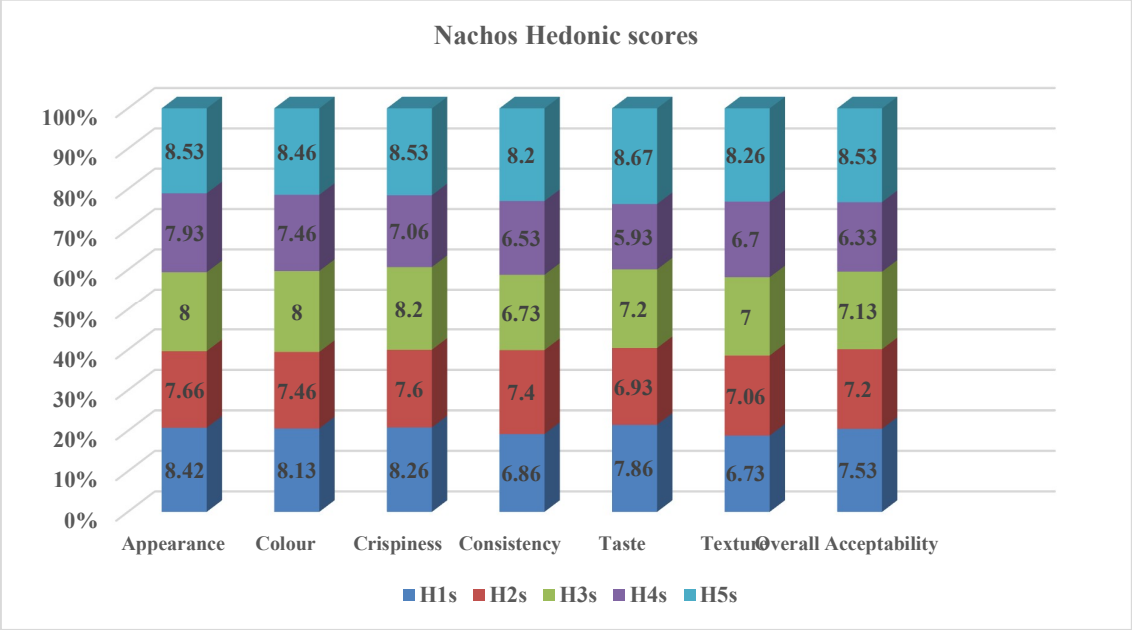

Figure 2: Mean Sensory Evaluation (9-point Hedonic) scores of developed samples of Lotus Stem Nachos H1s= contains 10g lotus stem powder, H2s= contains 20g lotus stem powder, H3s= contains 30g Lotus stem powder, H4s= contains 40g Lotus stem powder, and H5s= contains 50g of Lotus stem powder

Mean and standard deviation was calculated for all the sample. Sensory evaluation was done by 15 semi-trained professionals. The samples were scored on a scale 0f 1-9, 1 being disliked extremely, 2- disliked very much, 3- disliked moderately, 4- disliked slightly, 5- neither liked nor disliked, 6- liked slightly, 7- liked moderately, 8- liked very much, and 9- liked extremely **(Table 3)**.

4.2 MAHP & TOPSIS of Developed LS Nachos

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

4.2.1 MAHP technique-

Let 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.

Table 3: Mean±SD scores of developed samples of Lotus Stem Nachos

Sample	Appearance	Colour	Crispiness	Consistency	Taste	Texture	Overall acceptability
H1s	8.42±0.71	8.13±0.80	8.26±0.67	6.86±0.95	7.86±0.71	6.73±1.06	7.53±0.49
H2s	7.66±0.47	7.46±0.49	7.6±0.48	7.4±1.14	6.93±1.18	7.06±0.77	7.2±0.54
H3s	8±0.73	8±0.73	8.2±0.74	6.73±0.77	7.2±0.83	7±0.89	7.13±0.71
H4s	7.93±0.67	7.46±0.49	7.06±1.06	6.53±1.14	5.93±0.7717	6.7±0.80	6.33±0.69
H5s	8.53±0.49	8.46±0.49	8.53±0.49	8.2±0.65	8.67±0.47	8.26±0.77	8.53±0.49

Step 2: Calculation of 4th root was done **(Table 4)**.

4th root for H1s = $(1* 0.11* 0.11* 0.11* 0.11)^{1/4}$

H2s = $(3* 1* 0.33* 0.2* 0.14)^{1/4}$ H4s = $(7* 5* 3* 1* 0.33)^{1/4}$

H3s = $(5* 3* 1* 0.33* 0.2)^{1/4}$ H5s = $(9* 9* 9* 9* 1)^{1/4}$

Table 4: AHP calculation matrix of five samples of LS Nachos

	H1s	H2s	H3s	H4s	H5s	4th Root	PV
H1s	**1**	**0.11**	**0.11**	**0.11**	**0.11**	**0.11**	**0.0085**
H2s	**3**	**1**	**0.33**	**0.2**	**0.14**	**0.408036**	**0.031529**
H3s	**5**	**3**	**1**	**0.33**	**0.2**	**0.997491**	**0.077076**
H4s	**7**	**5**	**3**	**1**	**0.33**	**2.426196**	**0.187471**
H5s	**9**	**9**	**9**	**9**	**1**	**9**	**0.695425**
Sum	**25**	**18.11**	**13.44**	**10.64**	**1.78**	**12.94172**	**1**
Sum PV	**0.212491**	**0.570985**	**1.035896**	**1.99469**	**1.237857**	**5.051918**	

Step 3: Sum of all the 4th roots was done, which was found to be 12.94172.

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

PV(H1s) = 0.11/12.94172 PV(H4s) = 2.426196/12.94172

PV(H2s) = 0.408036/12.94172 PV(H5s) = 9/12.94172

PV(H3s) = 0.997491/12.94172

Step 5: Calculation of sum PV was done.

Sum PV for H1s= 0.0085* 25 = 0.212491 For H4s= 0.187471* 10.64 = 1.99469

For H2s= 0.031529* 18.11 = 0.570985 For H5s= 0.695425* 1.78 = 1.237857

For H3s= 0.077076* 13.44 = 1.035896

Total for Sum PV= $\lambda_{(max)}$ {Lambda- max} = 5.051918

Step 6: The next step is to calculate CI (Consistency Index). It is calculated using the formula

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

Where n = number of systems being compared

CI (Consistency Index) = (5.051918-5)/4= 0.01298

Step 7: Finally, CR (Consistency Ratio) was calculated by dividing CI by RI,

Where RI is Random Index. Values of RI are given in **Table 5**.

Table 5: Random Consistency Index

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**

In the study, a total of 7 criteria was compared, so, n = 7. RI for 7 is used to calculate the CR value.

CR = 0.01298/1.32 = 0.009833

The CR is the indicator of the consistency of the sample. 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. The calculated Consistency Ratio of our study is 0.009833, which is less than 0.1, so our pair-wise comparisons were consistent, and no corrective action was required for the comparison.

4.3.2 TOPSIS for Ranking the Samples of LS Nachos

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

Table 6: Mean scores obtained from sensory evaluation and calculated weights from the AHP technique of five different samples of LS nachos

Parameter	H1s	H2s	H3s	H4s	H5s
Appearance	8.42	7.66	8	7.93	8.53
Colour	8.13	7.46	8	7.46	8.46
Crispiness	8.26	7.6	8.2	7.02	8.53
Consistency	6.86	7.4	6.73	6.53	8.2
Taste	7.86	6.93	7.2	5.93	8.67
Texture	6.73	7.06	7	6.7	8.26
Overall Acceptability	7.53	7.2	7.13	6.33	8.53
Calculated weights	0.0085	0.031529	0.077076	0.187471	0.695425

(m= varieties of sample= 5; n = number of attributes= 7)

Table 7: Calculation of $(\Sigma x^2_{ij})^{1/2}$ for each row of five different samples of LS nachos

Parameter	H1s	H2s	H3s	H4s	H5s
Appearance	0.412798	0.394743	0.403953	0.436148	0.381286
Colour	0.39858	0.384436	0.403953	0.410298	0.378157
Crispiness	0.404954	0.391651	0.414052	0.386098	0.381286
Consistency	0.336317	0.381344	0.339825	0.359148	0.366535
Taste	0.385343	0.357124	0.363558	0.326148	0.387544
Texture	0.329944	0.363823	0.353459	0.368498	0.369217
Overall Acceptability	0.369165	0.371038	0.360023	0.348148	0.381286

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.

Step 2: Determination of the Positive and Negative Ideal Solution.

Positive Ideal Solution is the highest value for each attribute, while Negative Ideal Solution is the lowest value for each attribute.

Step 3: Determination of separation from Positive Ideal Solution-

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

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

Step 4: Calculation of the relative closeness to the ideal solution-

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

4.3.2.1 Ranking of LS Nachos

The best sample was found to be Sample H5s, followed by Sample H4s, H2s, and Sample H3s. Sample H1s were ranked last. Finally, the hierarchical chart of the LS nachos was made **(Figure 3)**.

Sample H5s was the most accepted, while sample H1s was the least accepted sample.

Table 8: Positive and Negative Ideal Situation.

Parameter	H1s	H2s	H3s	H4s	H5s	V+	V-
Appearance	0.003509	0.012446	0.031135	0.081765	0.265156	0.265156	0.003509
Colour	0.003388	0.012121	0.031135	0.076919	0.26298	0.26298	0.003388
Crispiness	0.003442	0.012348	0.031913	0.072382	0.265156	0.265156	0.003442
Consistency	0.002859	0.012023	0.026192	0.06733	0.254898	0.254898	0.002859
Taste	0.003275	0.01126	0.028022	0.061143	0.269508	0.269508	0.003275
Texture	0.002805	0.011471	0.027243	0.069083	0.256763	0.256763	0.002805
Overall Acceptability	0.003138	0.011698	0.027749	0.065268	0.265156	0.265156	0.003138

Where V+ is Positive Ideal Solution and V- is the Negative Ideal Solution of five different samples of LS nachos.

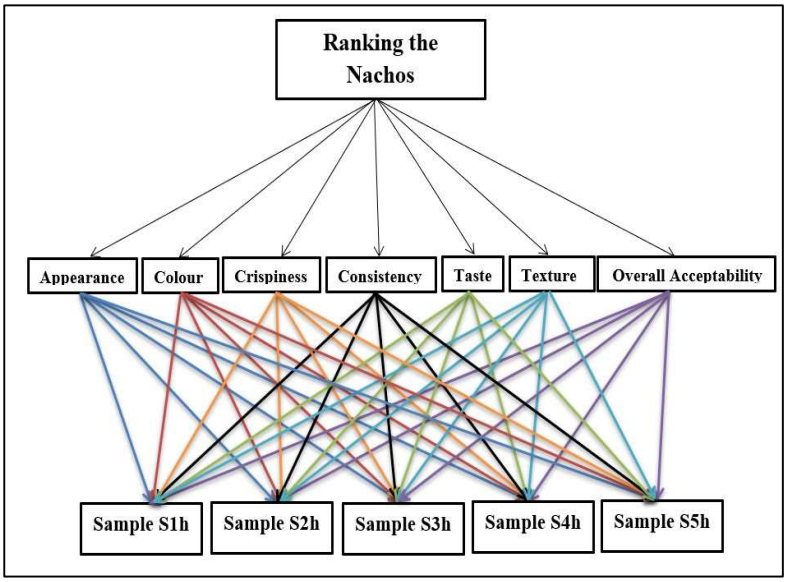

Figure 3: Nachos Hierarchical Chart

Table 9: Si values and Ci values for each sample. Ranks of five different samples of developed LS nachos

	H1s	H2s	H3s	H4s	H5s
Si+	0.686945	0.663923	0.618533	0.509106	0
Si-	0	0.023056	0.068582	0.179002	0.686945
Pi	0	0.033562	0.099812	0.260137	1
Rank	5	3	4	2	1

4.4 Proximate Analysis

Proximate analysis of all the five samples of nachos developed from LS was done, and the results are tabulated in **Table 10**.

4.4.1 Moisture (% by mass)

The moisture content per 100g of nachos ranged between 15.97-17.54. The recorded moisture content of H1s, H2s, H3s, H4s, and H5s was 16.73, 17.54, 16.23, 15.97, and 16.19, respectively.

4.4.2 Ash (% by mass)

The ash content of nachos ranged between 1.25-1.36. The recorded ash content of H1s, H2s, H3s, H4s, and H5s are 1.25, 1.28, 1.30, 1.33, and 1.36, respectively.

4.4.3 Fibre (in gram)

The fibre content per 100g of nachos ranged between 3.89-8.25. The recorded fibre content of H1s, H2s, H3s H4s, and H5s was 3.89, 4.62, 5.47, 7.04, and 8.25, respectively **(Table 10)**.

4.4.4 Fat (in grams)

The fat content per 100g of nachos ranged between 1.61-2.47. The recorded fat content of H1s, H2s, H3s, H4s, and H5s was 2.47, 2.3, 2.13, 1.96, and 1.61, respectively **(Table 10)**.

4.4.5 Protein (in grams)

The protein content per 100g of nachos ranged between 5.69-9.81. The recorded protein content of H1s, H2s, H3s, H4s, and H5s was 5.69, 6.13, 7.36, 8.58, and 9.81, respectively.

4.4.6 Carbohydrates (in grams)

The carbohydrate content per 100g of nachos ranged between 39.57-59.47. The recorded carbohydrate content of H1s, H2s, H3s, H4s, and H5s was 59.47, 54.51, 49.52, 44.55, and 39.57, respectively (Table 10).

4.4.7 Energy (in Kcal)

The number of calories given by 100g of nachos ranged between 212.01-282.87. Recorded calorie content of sample H1s, H2s, H3s, H4s, and H5s was 282.87, 263.26, 246.69, 230.16, and 212.01, respectively **(Table10)**.

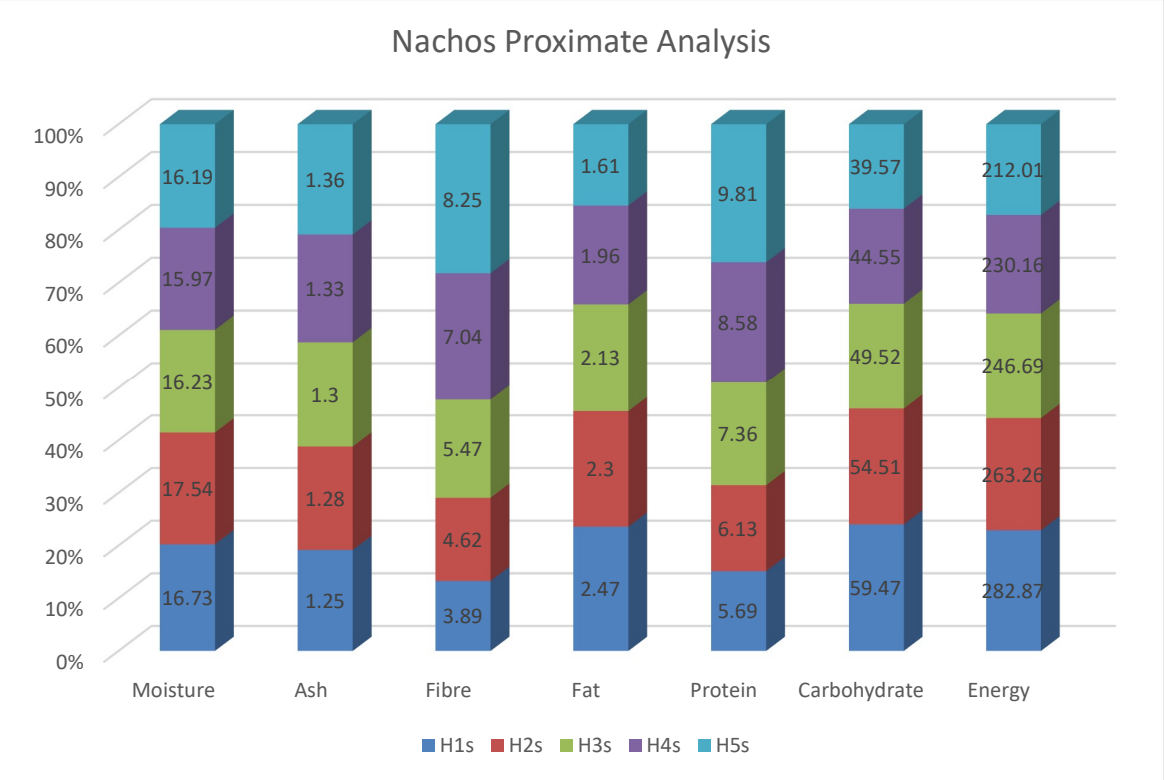

Figure 4: Proximate analysis of H1s, H2s, H3s, H4s, and H5s

Table 10: Nutritional Analysis of five samples of LS Nachos

Nutrient	H1s	H2s	H3s	H4s	H5s
Energy	282.87	263.26	246.69	230.16	212.01
Carbohydrate	59.47	54.51	49.52	44.55	39.57
Protein	5.69	6.13	7.36	8.58	9.81
Fat	2.47	2.3	2.13	1.96	1.61
Fibre	3.89	4.62	5.47	7.04	8.25
Ash	1.25	1.28	1.30	1.33	1.36
Moisture	16.73	17.54	16.23	15.97	16.19

CONCLUSION

From the results of the 9-scale Hedonic test, developed sample H5s of LS Nachos was found to be the most acceptable samples. From the results of MAHP & TOPSIS sample H5s of LS nachos were found to be ranked first. While from the results of Proximate analysis, sample H5s was found to be the richest source of fibre among the developed sample.

From the results of the 9-scale Hedonic test, MAHP & TOPSIS, and Proximate analysis, sample H5s of LS Nachos were found to be the best samples among all developed samples.

Sample H5s of LS Nachos can be used as an healthy substitute of various snacks available in the market.

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