INCORPORATION OF CHIA SEED (SALVIA HISPANICA L.) POWDER FOR THE DEVELOPMENT OF VALUE ADDED LADDU

Adya Yadav[1], Ranu Prasad[2] and Anisha Verma[3]

[1]Research Scholar, Ethelind College of Home Sciences, SHUATS, Allahabad, India,
[2] Dean, Ethelind College of Home Sciences, SHUATS, Allahabad, India
[3]Assistant Professor, Ethelind College of Home Sciences, SHUATS, Allahabad, India
[1]adya138@gmail.com

ABSTRACT

Chia (Salvia Hispanica L.) is a herbaceous plant belongs to Lamiaceae family. The seed colour are black, grey and spotted black seed with size ranging from 1 to 2 mm. Chia is planted in April or May and harvested in October. The objective of the study is to determine the nutritional analysis and antioxidant properties of Chia seed. Chia seed incorporated in Indian snacks to develop healthy calcium, fiber, protein and antioxidant rich products with the following objectives: : 1) To prepare and standardize antioxidant rich value added laddu by incorporating Chia seed powder. 2) To assess the sensory acceptability of the prepared products. 4) To determine the nutritional composition and antioxidant acitivity of best treatment on sensory acceptability . Chia seeds were grinded in the form of powder and incorporated in laddu at 0, 20, 30, 40, 50 percent respectively. Organoleptic evaluation was done using nine-point hedonic scale. Standard methods were used for determination of nutritional components of ingredients and products as well. The result of the study indicated that T3 (40%) for laddu was the most accepted variation. And had highest nutrient content like protein, fat, calcium, iron, fibre and antioxidants like DPPH and TPC than control. Research could be advanced to bring down the cost chia seeds within the reach of the common people through development of different breeds and varieties of chia seeds using genetic engineering.

Keywords: Chia (Salvia Hispanica L.), Chia Laddu, Nutritional analysis, Antioxidant properties

1. INTRODUCTION

Chia *(Salvia hispanica L.)* is a plant which comes under herb category and is harvested annually. It belongs to the *Lamiaceae* or *Labiatae* family[1]. Native Mexico and Guatemala, along with Bolivia, Nicaragua Ecuador, Northwest of Argentina, Parts of Australia, and the south-western United States grows it and consumes it and its commercial use is also done .Locally recognized for its medicinal uses. The Indigenous South American people of the pre-Columbian and Aztec eras gave *Salvia hispanica L.* its common name chia[2]. Chia is cultivated in April and May and harvested in the month of October. It can grow up to 1.75 metres (5.7 feet) tall, with opposite leaves that may be 4–8 cm (1.6–3.1 in) in length and 3–5 cm (1.2–2.0 in) in width. It bears flowers which are purple or white in colour and are produced in numerous clusters in a spike at the end of each stem. The seed may be of black, grey, and black spotted to white, and is oval in shape with size range of 1 to 2 millimetre. Mexico, Argentina and the south-western United States consume chia seeds[1]. It has been proposed as an alternative crop for the field crop industry because it can even grow in arid environments[3]. Light to medium clay or sandy soils

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suits the cultivation of *S. hispanica L*. Well-drained, moderately fertile soil is preferable but it can cope with acid soils and even moderate drought[4]. Moisture is needed for seedling establishment when chia seeds are sown, while wet soil is not suitable for the maturing chia plant during growth. The risk of chronic degenerative diseases is reduced by the nutritional value inherent in chemical compositions of functional foods in addition to health benefits which they offer[5]. Chia seeds are also known for their high antioxidant content[6,7]. Antioxidants present in it protect the sensitive fats in the seeds from going rancid[8]. Significant fact is that these antioxidants fight the production of free radicals, which may damage cell molecules and cause aging and diseases like cancer[9]. Compared to most plants it has high protein about 14% by weight. It also has a good balance of essential amino acids, to enable our body to make use of its protein content[10]. Protein has many benefits for our body and is the most useful dietary nutrient for weight loss. A protein rich intake reduces appetite and has exhibited to decrease obsessive thought about food by 60% and the craving for night time snacking by 50%[11]. For people who eat little or no animal products Chia seeds are surely an excellent protein source. Chia seeds have been found helpful in improving insulin sensitivity and thus in controlling blood sugar and stabilizing blood sugar levels after the meals[12,13].

Ready-to-eat meals or packaged food products and snacks have become integral part of diet routine of people across the world due to the fast paced and hectic lifestyle and changing eating patterns. However, essential nutrients and dietary fiber is significantly low in most of the snacks and are not ideally a healthy food option whereas, Chia seeds are good for health and therefore snacks made using chia seeds are a potent healthy food option available to people who have high affinity towards fast food and snacks. Thus rising popularity of chia seed containing snacks is envisaged to augment revenue generation of the global chia seed market.

2. MATERIALS AND METHOD

The present research study entitled **""Incorporation of Chia Seed *(Salvia Hispanica L.)* powder for the development of value added Laddu"** was carried out in Allahabad city to attain the objectives of Research by using following methodology.

1. **Experimental site:** The present investigation was carry out in the Nutrition Research Laboratory, Food Nutrition and Public Health, Ethelind College of Home Science.

2. **Procurement of Chia Seed**: Chia seed was purchased from supermarket of Allahabad.

3. **Preparation of Chia Seed Powder:** The seeds will be cleaned to remove the dust and impurities. The Chia seed are then grinded to homogeneous powder.

4. **Development of homemade products:** Four value added homemade products were developed by using Chia seed flour in different proportions. Instructions given in basic recipes was followed for making products. One sample served as controlled designated as 100 % standard (T_0) and other test recipes i.e T_1, T_2, T_3 and T_4 were made by incorporation of different concentration respectively.

5. **Organoleptic evaluation of developed products:** Organoleptic evaluation was done by a panel of 10 judges to assess the acceptability of the products based on the various sensory attributes like color, appearance, texture, flavor and taste. The evaluation was done on the 9 point Hedonic Scale based score card[14].

6. **Nutritional Analysis of nutritive value of developed products**

7. **Estimation of Antioxidants**

Nutritional Analysis of nutritive value of developed products

(a) Determination of moisture-Sample is heated at specified temperature of specific period of time and the loss in weight was recorded as moisture content of the sample.

(b) Determination of protein by (Lowry's method)- Protein reacts with the Folin- Ciocalteu reagent (FCR) to give a blue coloured complex. The colour so formed is due to the reaction of the alkaline copper with the protein as in the biuret test and the reduction of Phosphomolybdic – phosphotungste components in FCR by amino acid tyrosine and tryptophan present in the protein. The intensity of the blue colour is measured colometrically at 66 nm. The intensity of the colour depend on the amount of these aromatic amino acids present and will vary for different protein.

(c) Determination of Crude fibre- The dry fat free material is boiled successively with the diluted acid and the dilute alkali for a specific time period and filtered. The residue was dried and ignited. The loss in weight on ashing gives crude fibre. This consists of cellulose and lignocelluloses.

(d) Determination of Total Ash- Ash comprises the mineral contents of feeds, foods and feeding stuff which can be determined by igniting a known amount of dried material (moisture free) in a muffle furnace.

(f) Determination of Crude Fat- The sample of dried food stuff is placed in a continuous extractor (Soxhlet) and subjected to extraction with the ether. The ether soluble substance thus removed and collected in a flask, dried and weighed. The material extracted includes besides triglycerides, materials such as phospholipids, essential oils, pigments, waxes etc hence term 'crude fat'.

(g) Estimation of calorific value or energy value by calculation method (AOAC, 2007) - ENERGY= CHO×4+FAT×9+PROTEIN×4

(h) Estimation of Calcium

Preparation of Mineral Extract

Samples (500mg) were taken in a 100 ml conical flask and 5ml concentrated nitric acid was added. The mixture was evaporated in fume hood to dryness. After cooling 10 ml tertiary mixture (H_2SO_4: HCL: HNO_3= 1:4:10) was added and again evaporated to dryness and then cooled. Concentrated HCL (5ml) added and filtered. Volume makeup to 100ml with distilled water and then further analysis was done for mineral estimation.

Determination of Calcium

The extract(5ml) was added to distilled water(20ml) followed by 10 drops of sodium cyanide(1%),10 drops of hydroxylamine-HCL and one drops of 1% potassium ferricyanide solution which results into yellow colour development. Sodium hydroxide solution10% added till yellow colour disappeared. A pinch of mureoxide (ammonium perpurate) powder was added to the resultant solution. Titration was carried out with EDTA (0.02N).The end point is colour change from pink to purple. The amount of EDTA consumed is equivalent to the amount of calcium present in the sample, expressed as g/100g of sample.

(i) Determination of iron- Ferrous iron in acid solution reacts with the potassium thiocynate to form an intense red compound of ferric thiocynate. The compound was extracted with the organic potassium persulphate and measured colorimetrically at 560 nm.

Estimation of Antioxidants

(a) Determination of anti-oxidant activity: -.

Percent (%) anti radical activity

10 mg sample was weighed and dissolved in 10 ml of acidified methanol. Sample solution was further heated for 20 min at 40°C in boiling water bath and centrifuged.

100 µl of sample extract was taken in test tube and 150 µl of DPPH solution added. The final volume was made up to 3 ml with pure methanol. Solution was incubated for 15 min at room temperature and read the absorbance at 515 nm.

(b) Total phenolic content (TPC)- The total phenolic content (TPC) in different extracts was estimated[15] and expressed as gallic acid equivalents (GAE) mg/g on a dry weight basis.

The Folin–Ciocalteu (F–C) reagent is sensitive to reducing compounds, polyphenols and thus produces a blue colour complex. The F-C assay relies on the transfer of reducing equivalents (electrons), in the alkaline medium, from phenolic compounds to phosphomolybdic/phosphotungstic acid complexes, manifested in the formation of blue colour complexes [possibly $(PMoW_{11}O_{40})^{4-}$] that are determined on a UV-visible spectrophotometer (Thermo Fischer model Evolution 201) by monitoring the absorbance at 765 nm. Gallic acid was used as the reference compound for comparison and values are evaluated as the mg equivalent of gallic acid per gm of extract.

(c) Estimation of Total Flavonoid Content- Total flavonoid content (TFC) was estimated[16] and expressed as mg quercetin equivalent (QE)/g extract.

The principle involved in Aluminium chloride ($AlCl_3$) colorimetric method is that $AlCl_3$ forms acid stable complexes with the C-4 keto groups and either the C-3 or C-5 hydroxyl group of flavones and flavonols. In addition it also forms acid labile complexes with the ortho-dihydroxyl groups in the A- or B-ring of flavonoids. For building the calibration curve, quarcetin is used as a standard material. Various concentrations of standard quercetin solution were used to make a standard calibration curve[17].

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STATISTICAL ANALYSIS

The collected data will be analysed by using analysis of variance (ANOVA) ,chi-square test and other appropriate statistical tools as per objectives of the study. The collected data was analyzed with the help of appropriate statistical techniques.

TOOLS & DATA COLLECTION

The latest literature from Books, Journals will be collected for Research work. The data obtained from sensory evaluation were statistically analyzed by using analysis of variance technique (one way classification).

Formula used for statistical analysis:

Analysis of variance: $G = T_1 + T_2 + T_3 \ldots\ldots\ldots\ldots\ldots.. + T_n$

$G = R_1 + R_2 + R_3 \ldots\ldots\ldots\ldots\ldots + R_n$

1. Correction factor (C.F) $= G^2/rt$

2. Treatment S.S $= \dfrac{T_1^2 + T_2^2 + T_3^2 \text{------} + T_n^2}{r} - C.F$

3. Replication S.S $= \dfrac{R_1^2 + R_2^2 + R_3^2 \text{------} + R_n^2}{r} - C.F$

4. Total S.S=Sum of each observation-C.F

5. Error S.S= Total S.S-S.S due to treatments –S.S due to replications

G= Ground total

t = Treatment

r =Replication

S.S= Sum of squares

Critical difference (C.D)$= \sqrt{2} \times E.M.S.S/r$

C.D=S.E× t(5%) on error d.f

Where, S.E=Standard error

✓ E.M.S.S=Error mean sum of square

Source of variation	d.f	S.S	M.S.S	F Calculated	F total (5%)	R cal.
Due to treatment(T)	t-1	S.S.tr	S.S Tr /t-1	M.S.S.Tr/E.M.S.S		S/NS
Due to replication(R)	r-1	R.S.S	R.S.S /r-1	M.R.S.S/E.M.S.S		

Due to error	(t-1) (r-1)	E.S.S	E.S.S / (t-1) (r-1)			
Total	(rt-1)	t.S.S				

3. RESULT & DISCUSSION

3.1 Organoleptic Evaluation of Laddu

(a) Colour & Appearance

Descriptives Colour & Appearance

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
T0	10	7.60	.516	.163	7.23	7.97	7	8
T1	10	6.60	.516	.163	6.23	6.97	6	7
T2	10	6.30	.675	.213	5.82	6.78	6	8
T3	10	8.50	.527	.167	8.12	8.88	8	9
T4	10	5.50	.707	.224	4.99	6.01	5	7
Total	50	6.90	1.199	.170	6.56	7.24	5	9

From the table,we found the mean score of the colour & appearance for each of the treatment of Laddu. T3 has the highest mean value in comparison to rest of the treatments, which indicates that colour & appearance of T3 treatment of Laddu has been preferred over other treatments by majority of the panelist.

Test of Homogeneity of Variances

Colour & Appearance

Levene Statistic	df1	df2	Sig.
.424	4	45	.791

According to this test, there is homogenity of variances or variance between the groups are not significantly different as significance value is greater than 0.05.

Anova

Colour & Appearance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	54.600	4	13.650	38.632	.000
Within Groups	15.900	45	.353		
Total	70.500	49			

The table shows that there is a significant difference in colour & appearance of atleast two of the three treatments for Laddu as P value <.05. Hence, null hypothesis is rejected.

Multiple Comparisons

Dependent Variable: Colour & Appearance

Tukey HSD

(I) Treatments of Laddu	(J) Treatments of Laddu	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
T0	T1	1.000*	.266	.004	.24	1.76
	T2	1.300*	.266	.000	.54	2.06
	T3	-.900*	.266	.012	-1.66	-.14
	T4	2.100*	.266	.000	1.34	2.86
T1	T0	-1.000*	.266	.004	-1.76	-.24
	T2	.300	.266	.791	-.46	1.06
	T3	-1.900*	.266	.000	-2.66	-1.14
	T4	1.100*	.266	.001	.34	1.86
T2	T0	-1.300*	.266	.000	-2.06	-.54
	T1	-.300	.266	.791	-1.06	.46
	T3	-2.200*	.266	.000	-2.96	-1.44
	T4	.800*	.266	.033	.04	1.56
T3	T0	.900*	.266	.012	.14	1.66
	T1	1.900*	.266	.000	1.14	2.66
	T2	2.200*	.266	.000	1.44	2.96
	T4	3.000*	.266	.000	2.24	3.76
T4	T0	-2.100*	.266	.000	-2.86	-1.34
	T1	-1.100*	.266	.001	-1.86	-.34
	T2	-.800*	.266	.033	-1.56	-.04
	T3	-3.000*	.266	.000	-3.76	-2.24
*. The mean difference is significant at the 0.05 level.						

The above table shows that there is a significant difference in colour & appearance between all the treatments as P<.05. However, there is no significance difference between T1 & T2, T0 & T3 as the the P >.05.

Colour & Appearance

Tukey HSD

Treatments of Laddu	N	Subset for alpha = 0.05			
		1	2	3	4
T4	10	5.50			
T2	10		6.30		
T1	10		6.60		
T0	10			7.60	
T3	10				8.50
Sig.		1.000	.791	1.000	1.000

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 10.000.

The above table shows that all the treatments differed significantly in colour & appearance as all of them found in different subset while T1 & T2 found in same subset 2 which indicates no significant difference between T1 & T2. Hence, majority of panelist preferred T3 treatment of Laddu as the score for T3 (8.50) is higher than T0, T1, T2, T4.
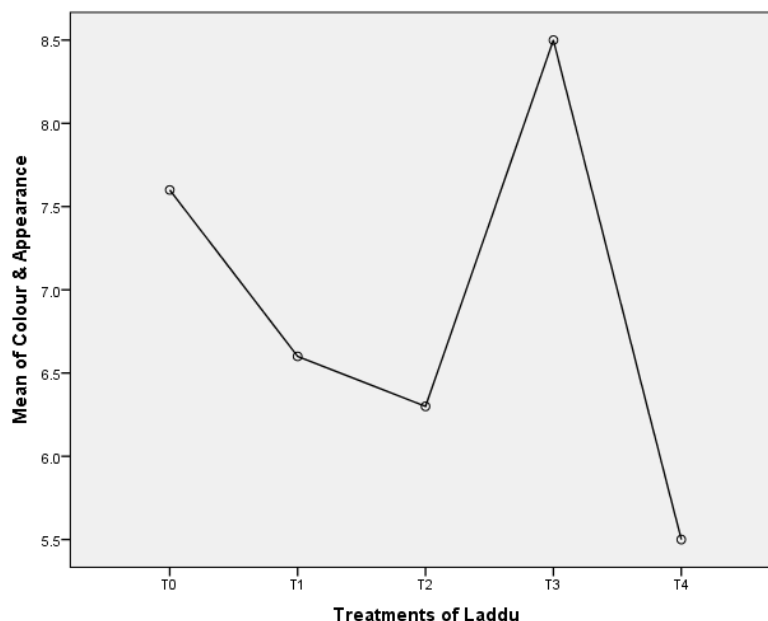
(b) Body & Texture

Descriptives

Body & Texture

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
T0	10	7.90	.568	.180	7.49	8.31	7	9
T1	10	6.60	.516	.163	6.23	6.97	6	7
T2	10	6.80	.789	.249	6.24	7.36	6	8
T3	10	8.70	.483	.153	8.35	9.05	8	9
T4	10	6.10	.568	.180	5.69	6.51	5	7
Total	50	7.22	1.112	.157	6.90	7.54	5	9

From the table, we found the mean score of the body & texture for each of the treatment of Laddu. T3 has the highest mean value in comparison to rest of the treatments, which indicates that body & texture of T3 treatment of Laddu has been preferred over other treatments by majority of the panellist.

Test of Homogeneity of Variances

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Body & Texture

Levene Statistic	df1	df2	Sig.
1.183	4	45	.331

According to this test, there is homogenity of variances or variance between the groups are not significantly different as significance value is greater than 0.05.

ANOVA

Body & Texture

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	44.680	4	11.170	31.613	.000
Within Groups	15.900	45	.353		
Total	60.580	49			

The table shows that there is a significant difference in body & texture of atleast two of the three treatments for Laddu as P value <.05. Hence, null hypothesis is rejected.

Multiple Comparisons						
Dependent Variable: Body & Texture Tukey HSD						
(I) Treatments of Laddu	(J) Treatments of Laddu	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
T0	T1	1.300*	.266	.000	.54	2.06
	T2	1.100*	.266	.001	.34	1.86
	T3	-.800*	.266	.033	-1.56	-.04
	T4	1.800*	.266	.000	1.04	2.56
T1	T0	-1.300*	.266	.000	-2.06	-.54
	T2	-.200	.266	.943	-.96	.56
	T3	-2.100*	.266	.000	-2.86	-1.34
	T4	.500	.266	.342	-.26	1.26
T2	T0	-1.100*	.266	.001	-1.86	-.34
	T1	.200	.266	.943	-.56	.96
	T3	-1.900*	.266	.000	-2.66	-1.14
	T4	.700	.266	.081	-.06	1.46
T3	T0	.800*	.266	.033	.04	1.56
	T1	2.100*	.266	.000	1.34	2.86
	T2	1.900*	.266	.000	1.14	2.66
	T4	2.600*	.266	.000	1.84	3.36
T4	T0	-1.800*	.266	.000	-2.56	-1.04
	T1	-.500	.266	.342	-1.26	.26
	T2	-.700	.266	.081	-1.46	.06

	T3	-2.600*	.266	.000	-3.36	-1.84
	*. The mean difference is signizicant at the 0.05 level.					

The above table shows that there is a significant difference in body & texture between all the treatments as P<.05. However, there is no significance difference between T1 & T2, T1 & T4, T2 & T4 as the the P >.05.

Body & Texture				
Tukey HSD				
Treatments of Laddu	N	Subset for alpha = 0.05		
		1	2	3
T4	10	6.10		
T1	10	6.60		
T2	10	6.80		
T0	10		7.90	
T3	10			8.70
Sig.		.081	1.000	1.000
Means for groups in homogeneous subsets are displayed.				
a. Uses Harmonic Mean Sample Size = 10.000.				

The above table shows that all the treatments differed significantly in body & texture as all of them found in different subset while T1,T2 & T4 found in same subset 1 which indicates no significant difference between T1, T2 & T4. Hence, majority of panelist preferred T3 treatment of Laddu as the score for T3 (8.70) is higher than T0, T1, T2, T4.
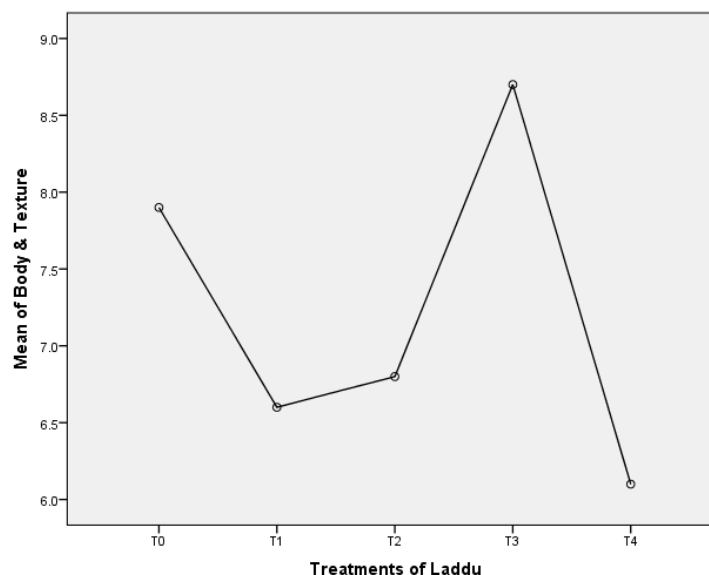
(c) Taste & Flavour

Descriptives
Taste & Flavour

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	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
T0	10	7.70	.483	.153	7.35	8.05	7	8
T1	10	6.70	.483	.153	6.35	7.05	6	7
T2	10	6.50	.707	.224	5.99	7.01	6	8
T3	10	8.70	.483	.153	8.35	9.05	8	9
T4	10	5.60	.699	.221	5.10	6.10	5	7
Total	50	7.04	1.212	.171	6.70	7.38	5	9

Test of Homogeneity of Variances			
Taste & Flavour			
Levene Statistic	df1	df2	Sig.
1.615	4	45	.187

According to this test, there is homogenity of variances or variance between the groups are not significantly different as significance value is greater than 0.05.

ANOVA					
Taste & Flavour					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	56.720	4	14.180	41.980	.000
Within Groups	15.200	45	.338		
Total	71.920	49			

The table shows that there is a significant difference in taste & flavour of atleast two of the three treatments for Laddu as P value <.05. Hence, null hypothesis is rejected.

Multiple Comparisons						
Dependent Variable: Taste & Flavour						
Tukey HSD						
(I) Treatments of Laddu	(J) Treatments of Laddu	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
T0	T1	1.000*	.260	.003	.26	1.74
	T2	1.200*	.260	.000	.46	1.94
	T3	-1.000*	.260	.003	-1.74	-.26
	T4	2.100*	.260	.000	1.36	2.84
T1	T0	-1.000*	.260	.003	-1.74	-.26
	T2	.200	.260	.938	-.54	.94
	T3	-2.000*	.260	.000	-2.74	-1.26

	T4	1.100*	.260	.001	.36	1.84
T2	T0	-1.200*	.260	.000	-1.94	-.46
	T1	-.200	.260	.938	-.94	.54
	T3	-2.200*	.260	.000	-2.94	-1.46
	T4	.900*	.260	.010	.16	1.64
T3	T0	1.000*	.260	.003	.26	1.74
	T1	2.000*	.260	.000	1.26	2.74
	T2	2.200*	.260	.000	1.46	2.94
	T4	3.100*	.260	.000	2.36	3.84
T4	T0	-2.100*	.260	.000	-2.84	-1.36
	T1	-1.100*	.260	.001	-1.84	-.36
	T2	-.900*	.260	.010	-1.64	-.16
	T3	-3.100*	.260	.000	-3.84	-2.36
*. The mean difference is significant at the 0.05 level.						

The above table shows that there is a significant difference in taste & flavour between all the treatments as $P<.05$. However, there is no significance difference between T1 & T2 as the the $P >.05$.

Taste & Flavour					
Tukey HSD					
Treatments of Laddu	N	Subset for alpha = 0.05			
		1	2	3	4
T4	10	5.60			
T2	10		6.50		
T1	10		6.70		
T0	10			7.70	
T3	10				8.70
Sig.		1.000	.938	1.000	1.000
Means for groups in homogeneous subsets are displayed.					
a. Uses Harmonic Mean Sample Size = 10.000.					

The above table shows that all the treatments differed significantly in taste & flavour as all of them found in different subset while T1 & T2 found in same subset 2 which indicates no significant difference between T1 & T2. Hence, majority of panelist preferred T3 treatment of Laddu as the score for T3 (8.70) is higher than T0, T1, T2, T4.
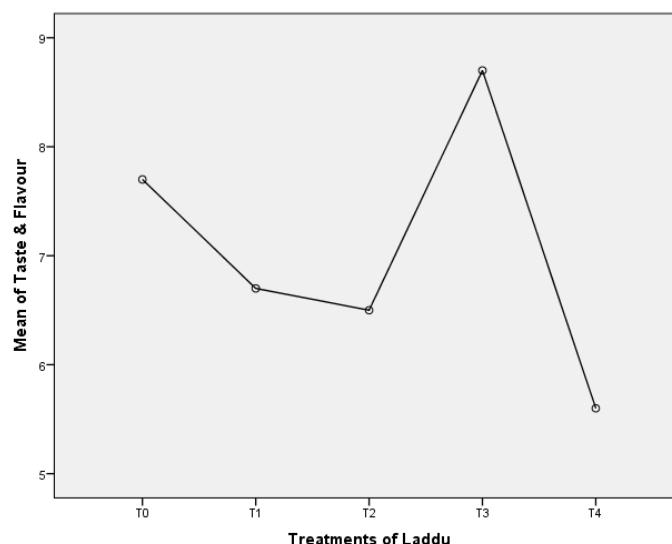
(d) Overall Acceptibility

Descriptives							
Overall Acceptability							
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
T0	10	7.70	.675	.213	7.22	8.18	7	9
T1	10	6.70	.483	.153	6.35	7.05	6	7
T2	10	6.40	.699	.221	5.90	6.90	6	8
T3	10	8.60	.516	.163	8.23	8.97	8	9
T4	10	5.60	.699	.221	5.10	6.10	5	7
Total	50	7.00	1.212	.171	6.66	7.34	5	9

From the table, we found the mean score of the overall acceptibility for each of the treatment of Laddu. T3 has the highest mean value in comparison to rest of the treatments, which indicates that overall acceptibility of T3 treatment of Laddu has been preferred over other treatments by majority of the panelist.

Test of Homogeneity of Variances			
Overall Acceptability			
Levene Statistic	df1	df2	Sig.
.687	4	45	.605

According to this test, there is homogenity of variances or variance between the groups are not significantly different as significance value is greater than 0.05.

ANOVA				
Overall Acceptability				
	Sum of Squares	df	Mean Square	F	Sig.

Between Groups	54.600	4	13.650	35.302	.000
Within Groups	17.400	45	.387		
Total	72.000	49			

The table shows that there is a significant difference in overall acceptibility of atleast two of the three treatments for Laddu as P value <.05. Hence, null hypothesis is rejected.

Multiple Comparisons

Dependent Variable: Overall Acceptibility

Tukey HSD

(I) Treatments of Laddu	(J) Treatments of Laddu	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
T0	T1	1.000*	.278	.007	.21	1.79
	T2	1.300*	.278	.000	.51	2.09
	T3	-.900*	.278	.018	-1.69	-.11
	T4	2.100*	.278	.000	1.31	2.89
T1	T0	-1.000*	.278	.007	-1.79	-.21
	T2	.300	.278	.816	-.49	1.09
	T3	-1.900*	.278	.000	-2.69	-1.11
	T4	1.100*	.278	.002	.31	1.89
T2	T0	-1.300*	.278	.000	-2.09	-.51
	T1	-.300	.278	.816	-1.09	.49
	T3	-2.200*	.278	.000	-2.99	-1.41
	T4	.800*	.278	.046	.01	1.59
T3	T0	.900*	.278	.018	.11	1.69
	T1	1.900*	.278	.000	1.11	2.69
	T2	2.200*	.278	.000	1.41	2.99
	T4	3.000*	.278	.000	2.21	3.79
T4	T0	-2.100*	.278	.000	-2.89	-1.31
	T1	-1.100*	.278	.002	-1.89	-.31
	T2	-.800*	.278	.046	-1.59	-.01
	T3	-3.000*	.278	.000	-3.79	-2.21
*. The mean difference is significant at the 0.05 level.						

The above table shows that there is a significant difference in overall acceptibility between all the treatments as P<.05. However, there is no significance difference between T1 & T2 as the the P >.05.

Overall Acceptability

Tukey HSD

Treatments of Laddu	N	Subset for alpha = 0.05			
		1	2	3	4
T4	10	5.60			
T2	10		6.40		
T1	10		6.70		

T0	10			7.70	
T3	10				8.60
Sig.		1.000	.816	1.000	1.000
Means for groups in homogeneous subsets are displayed.					
a. Uses Harmonic Mean Sample Size = 10.000.					

The above table shows that all the treatments differed significantly in overall acceptibility as all of them found in different subset while T1 & T2 found in same subset 2 which indicates no significant difference between T1 & T2. Hence, majority of panelist preferred T3 treatment of Laddu as the score for T3 (8.60) is higher than T0, T1, T2, T4.
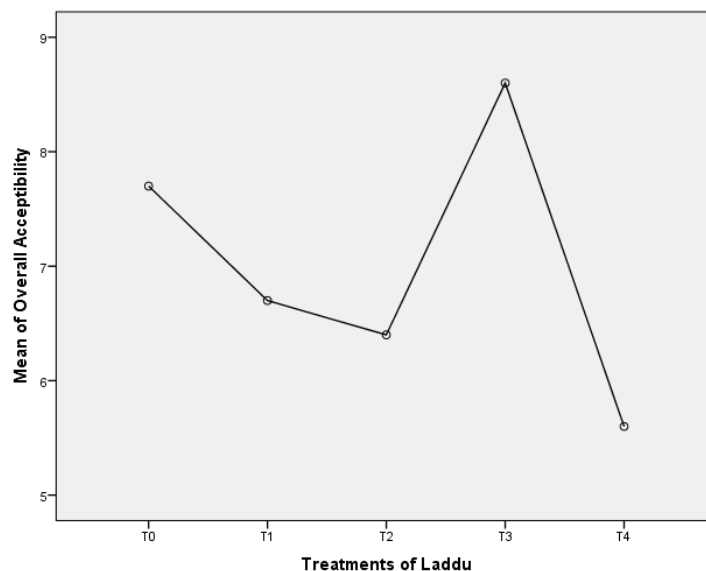
3.2 PROXIMATE AND MICRONUTRIENT COMPOSITION OF BEST DEVELOPED VALUE ADDED FOOD PRODUCTS

Table 3.2. Proximate and Mineral composition of best developed value added food products

Nutrients (/100gm)	Laddu (T3)
Moisture (g)	1.54±0.2
Protein (g)	17.43±0.06
Fat (g)	18.95±0.01
Crude fibre (g)	23.52±0.05
Carbohydrate (g)	36.64±0.07
Energy (kcal)	386.83±0.03
Total ash (g)	1.92±0.04

Calcium (mg)	531.76±0.05
Iron(mg)	4.89±0.04

Table 3.2. shows that amount of protein was good in prepared value added laddu showed highest protein content i.e 17.43 g/100g, crude fibre 23.52g, calcium 531.76mg and iron 4.89mg was also good in Chia incorporated value added product.

3.3 ANTIOXIDANT COMPOSITION OF BEST DEVELOPED VALUE ADDED FOOD PRODUCTS

Table 3.3 Antioxidant composition of best developed value added food products

Antioxidant	Laddu (T3)
(/100gm)	
DPPH (%)	58.34±0.05
Total Phenol content (mg GAE)	25.77±0.03
Total Flavonoid Content (mg GAE)	0.29±0.02

Table 3.3 shows that DPPH, TPC and Total flavonoid value were good in prepared products. Chia seed is rich in antioxidants which helps in preventing many degenerative diseases.

3.4 COMPARISON OF CONTROL AND BEST ACCEPTED TREATMENT OF VALUE ADDED FOOD PRODUCTS

Table 3.4 (a) Comparison of proximate composition of the control and best accepted treatment of *"Laddu"* (*Per* 100g)

Nutrients (/100gm)	T_0	T_3	difference	T (cal)	T (tab.)	Results
Moisture (g)	4.40±0.06	1.54±0.05	2.86	495.36	4.303	S
Protein (g)	10.17±0.02	17.43±0.03	-7.26	-1257.46	4.303	S
Fat (g)	8.81±0.05	18.95±0.04	-10.14	-1756.30	4.303	S
Fibre (g)	1.63±0.06	23.52±0.07	-21.89	-3791.45	4.303	S
Carbohydrate (g)	73.60±0.07	36.64±0.05	36.96	3075.81	4.303	S
Energy (Kcal)	414.37±0.02	386.83±0.03	27.54	4770.06	4.303	S

*Results are mean ±SD of three determinations. NS- Non Significant S- Significant

Table 3.4(a) shows that Chia seed incorporated value added Laddu (T_3) has significant difference in all the parameters of proximate analysis from the control Laddu. T_3 has 386.83kcal energy which is low from T_0 (417.37kcal) which makes it a low calorie option. Carbohydrate content is low in T_3 (36.64gm)

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than T_0 (73.60gm) which makes it a healthier option for the people to stay fit and healthy. Protein content of T_3 is higher than T_0 which makes it even more nutritious as protein comes from seeds are considered as good quality protein because of its essential amino acid content. As Chia is a seed, Fat content (n-3 fatty acid) is higher, so the developed product T_3 is higher in fats than T_0. Fibre in Chia incorporated value added laddu (T_3) is much higher 23.52gm as compared to (T_0) which is only 1.63gm, so the value added laddu are rich in fibre. All the nutrients make the treatment T_3 even healthier option for the population.

Table 3.4 (b) Comparison of minerals content of the control and best treatment in *"Laddu"*(Per 100g).

Nutrients (/100gm)	T_0	T_3	difference	T cal	T Tab	Results
Total Ash (g)	1.39±0.03	1.92±0.04	-0.53	-12.30	4.303	S
Calcium (mg)	50.65±0.05	531±0.06	-481.11	-72165.5	4.303	S
Iron (mg)	0.68±0.05	4.89±0.06	-4.21	-477.74	4.303	S

*Results are mean ±SD of three determinations. NS- Non Significant S- Significant

Table 3.4 (b) shows that calcium content in T_3 treatment (531mg) is very high than T_0 control (50.65mg) of laddu and iron content of T_0 sample of laddu is 0.68mg is lower than iron content of T_3 sample which is 4.89mg of per 100gm of Chia incorporated value added laddu.

Table 3.4 (c) Comparison of antioxidant content of the control and best treatment in *"Laddu"* (*Per* 100g).

Nutrients (/100gm)	T_0	T_3	Difference	T (cal.)	T (Tab.)	Results
DPPH (%)	12.49±0.06	58.34±0.04	-45.85	-5199.27	4.303	S
Total Phenolic content (mgGAE)	11.73±0.08	25.77±0.05	-14.04	-810	4.303	S
Total Flavanoids (mgGAE)	0.027±0.006	0.029±0.007	-0.002	-3.464	4.303	S

*Results are mean ±SD of three determinations, NS- Non Significant, S- Significant

Table 3.4 (c) shows that DPPH, Total phenol Content and total flavonoids content is higher in T_3 compared to T_0. DPPH in T_3 is 58.34% and TPC is 25.77mg. So the value added laddu enhance the level of antioxidant of food product by the incorporation of Chia seed.

4. CONCLUSION

Thus, the present research concludes that Chia seed Laddu were organolepticaly acceptable. The developed recipes were found higher in macronutrients i.e., protein, fat (n-3 fatty acid), minerals i.e., calcium and iron, antioxidants i.e., total phenol content. Energy content inT3 treatment of laddu was 386.83kcal, which was found lesser in calories than control treatment, protein content in T3 treatment of laddu was 17.43g, which was found higher in protein than control treatment, total fat content inT3 treatment of laddu was 18.95g, which was found higher in fat than control treatment, crude fiber content inT3 treatment of laddu was 23.52g, which was found higher in crude fiber than control treatment, carbohydrate content inT3 treatment of laddu was 36.64g, which was found lesser in carbohydrate than control treatment, moisture content inT3 treatment of laddu was 1.54g, which was found lower in moisture than control treatment, total ash content inT3 treatment of laddu was 1.92g, which was found higher in total ash than control treatment, calcium content inT3 treatment of laddu was 531.76mg, which was found higher in calcium than control treatment, iron content inT3 treatment of laddu was 4.89mg, which was found higher in iron than control treatment ,Total Phenolic content inT3 treatment of laddu was 5.77mg, which was found lower in Total phenolic content than control treatment, Total Flavonoid content inT3 treatment of laddu was 0.29mg, which was found higher in Total Flavonoid content than control.

Girls and women generally have constipation problem, Chia provides 28.51gm/100gm of fiber and Chia incorporated cookies have 31.67gm/100gm and laddu has 23.52gm/100gm of fiber which proves it can be good source of fiber for them.

During pregnancy and lactation requirement of Protein, calcium, iron, fiber increases. Chia seed are the best source which fulfill their requirement without having fullness in stomach. 2-3 laddu are enough for to manage their dietary requirement during this period.

Old age people generally suffers from depletion of calcium in the body because of which they become more prone to bone fracture, arthritis, bone formation and many others. As the calcium content in Chia seed and its incorporated products are discussed earlier .It can prove to be good source for them.

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