Educational Administration: Theory and Practice
2024,30(4), 2466-2474
ISSN:2148-2403
https://kuey.net/

Research Article

Preparation, Quality, And Sensory Evaluation Of Fiber-Rich Healthy Noodles Prepared From *Ficus Religiosa:* A Product Analysis By MAHP And TOPSIS Statistical Method

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Citation: Luxita Sharma et al. (2024), Preparation, Quality, And Sensory Evaluation Of Fiber-Rich Healthy Noodles Prepared From *Ficus Religiosa:* A Product Analysis By MAHP And TOPSIS Statistical Method, *Educational Administration: Theory And Practice*, *30*(4), 2466-2474, Doi: 10.53555/kuey.v30i4.1876

ARTICLE INFO

ABSTRACT

Nowadays in the running world, people are declining toward processed, ready-to-eat, and convenient food. The noodle plays at the top among the ready-to-eat food, because the noodles can be cooked within a minute and it is more convenient, easy to cook by any age group, and too tasty. Obesity is one of the silent killers because it makes the person slowly hypertensive, atherosclerosis, heart disease, liver disease, kidney disease, and many more. In the present time, gaining good health is a most difficult task for everyone especially when someone suffering from metabolic disease. Generally, refined wheat or rice flour is used to prepare noodles which are not healthy for obese patients as it contains high calories and increases body weight. Hence, the idea of the research was to develop a food product (noodles), which is a recipe liked by all but making it a more-healthier way by replacing the unhealthy ingredients with healthier ones so that the harmful effects on health could be prevented. The main objective behind product development was to develop a product that is nutritionally rich. The product developed in this study is protein and fiber-rich noodles at various levels. EP1, EP2, EP3, and EP4 were prepared by using Powder/flour of Quinoa, Oats, Horse gram, and *Ficus religiosa*. EP1, EP2, EP3, and EP4 contain *Ficus religiosa* and quinoa in the combination of (5+35) g, (10+30) g, (15+25) g, and (20+20) g in combination with 60 g of prepared flour (horse gram 10 g, rolled oatmeal 15 g, wheat flour 20g and starch 15 g). EP1 as it is clearly seen, containing Ficus powder (5 g), and quinoa (35 g), with 60 g prepared flour is rated best among all four samples in terms of taste, color, texture, firmness, stickiness, and overall acceptability. A Product Analysis was done by MAHP and TOPSIS Statistical Method. The newly developed noodle contains more amount of fiber (13.27 g). The calories content of newly developed noodles (334.89 Kcal) and high protein content (11.33 g). The formed noodle was rich in dietary fiber and protein which decreases energy intake and helps to maintain body weight.

Keywords: Ficus religiosa; Oatmeal; quinoa; horse gram; noodles; Food Products

1. Introduction

By 2050, the human population is expected to reach nine billion (Van Huis et al., 2013). For this reason, food insecurity is an immediate current concern as a proportion of the world population continues to have limited access to nutrient-dense food sources (McKenzie & Williams, 2015). The United Nations has predicted that food production will need to double to meet the needs of the growing population (Assembly U. G, 2009).
The search for a new and unique source of protein to meet the daily day requirements of the growing and large population is a remarkable need of the present day (Wheeler et al., 1998). Cereals and pulses are known as the major source of calories and protein and fulfill the requirement of the large population of the world (Bhama & Sadana, 2004).

Nowadays in the running world, people are declining toward processed, ready-to-eat, and convenient food. The noodle plays at the top among the ready-to-eat food, because the noodles can be cooked within a minute and it is more convenient, easy to cook by any age group, and too tasty.

But many noodles are not as convenient from a health perspective, because most noodles are prepared from processed cereal products, which are easy to digest. So, the foods that are easily digested will easily get absorbed by the body. This absorption may lead to obesity if we do not follow the proper lifestyle management.

Obesity is one of the silent killers because it makes the person slowly hypertensive, atherosclerosis, heart disease, liver disease, kidney disease, and many more.

In the present time, gaining good health is a most difficult task for everyone especially when someone suffering from metabolic disease. Generally, refined wheat or rice flour is used to prepare noodles which is not healthy for diabetes and obese patients as it contains high calories and increases blood glucose levels.

Hence, the idea of the research was to develop a food product (noodles), which is a recipe liked by all but making it a more-healthier way by replacing the unhealthy ingredients with healthier ones so that the harmful effects on health could be prevented.

1.1 Quinoa (*Chenopodium quinoa*)

Quinoa (*Chenopodium quinoa*) is native to the Andean region. The seed is attracting the global due to its unique and beneficial nutritive value. The nutrient content such as protein in the seed is much higher than the other cereals group and a fully packed with essential amino acids. The seed can be used as an alternative for people having issues with milk protein. It is a good source of essential fatty acids, a high amount of dietary fiber, vitamins, and minerals, low glycemic carbohydrates, and gluten-free (Angeli et al., 2020).

1.2 Oats (*Avena sativa*)

Oats (*Avena sativa*) has made a vide attention for their high nutritive contents such as dietary fibers, phytochemicals, and another useful nutrient. Several research evidence that the consumption of oats lowers hypercholesterolemia, obesity, constipation, and some cancers. As the seeds possess a rich amount of dietary fibers both soluble and insoluble. It is also considered safe for celiac patients. The development of food products using oats can be helpful for several diseases also (Rasane et al., 2015).

1.3 Horse gram (*Macrotyloma uniflorum*)

Horse gram (*Macrotyloma uniflorum*) is unexplored and underutilized legume food. The seed contains a good amount of protein, good carbohydrates, and low energy. nowadays, Due to its high nutritive content, it placed an important place in daily meals. Other than the nutritional aspect it is also linked with the reduction of various health issues due to the presence of bioactive molecules in it. Besides its good nutrient, it also contains some anti-nutritional factors such as phytic acids, and proteinase inhibitors that show some physiological effects. The seeds were used in past in folk/traditional and alternative medicine as a potent therapeutic agent to treat several diseases of the kidney, throat, spiles, urinary and common colds, etc (Prasad & Singh, 2015).

1.4. Ficus religiosa

Peepal (*Ficus religiosa*) is one of the oldest, sacred plants in Indian literature. It belongs to the family *Moraceae and the* genus *Ficus* (Bhalerao & Sharma, 2014). It is also known as the bodhi tree, peepal tree, or ashvattha tree. It is native to sub-Himalaya, Bengal, and central India (Singh, et al., 2015; Gautam et al., 2014).

All parts of this tree are rich in phytochemicals and are used in various food and medicinal preparations. The plant is reported to display antidiabetic, antibacterial, anthelmintic, sexual disorders, immunomodulatory, antioxidant, wound healing, hypoglycemic, hypolipidemic, and anticonvulsant (Chandrasekar et al., 2014). Dried fig fruit of *F. religiosa* have been reported to have total carbohydrate 68.33 gm, dietary fibre 69.43 gm, calcium 848 mg, magnesium 224 mg, phosphorus 165 mg and iron 6 mg (Verma & Gupta, 2015).

1.5 Amis and objectives

- To develop a new food product from the available food sources enriched with dietary fiber, protein, carbohydrates and low energy.
- To assess the organoleptic evaluation of the developed product by standardizing variation.
- Statistical analysis of the developed product by MAHP and TOPSIS method.
- To determine the nutritive value (Dietary fiber, protein, fat, and energy) of the developed product (noodles).

2. Materials and Methods

2.1Procurement of raw materials

All the raw materials (Quinoa, Oats, Horse gram, and *Ficus religiosa*) were purchased from Punchgaon, the departmental store and campus in Amity University Manesar, Haryana, India. All the preparation was done in the nutrition Lab of Amity University Gurugram. The appropriate amount of the ingredients was weighed using an electronic balance and stored carefully.

2.2 Preparation methods involve noodle preparation

Soaking: Wash the whole quinoa, and horse gram thoroughly with running tap water. Then soaked the seeds for 8 hours at room temperature to reduce the antinutritional components present in these seeds like trypsin, tannin, phytate, and oxalates, and to increase the protein and vitamin C content (Moktan & Ojha, 2016).

Germination: After soaking drain out the entire water. Then we put it in a cold and shaded area for the proper germination of horse gram seed in muslin cloths for 2 days (48 hours). The germination process was conducted to increase the protein, fiber, polyphenol content, and antioxidant content whereas again the antinutritional component can be reduced to some extent through this process (Moktan & Ojha, 2016).

Sun drying: The germinated seeds were sundried continuously for 4 days with 6 hours of exposure to the sun daily.

Grinding: The dried seeds were ground to their flour form. The products obtained after grinding are palatable and easily digestible forms that can save cooking time. All the samples were ground separately.

Dough formation: All the ingredients were mixed along with the standardized amount (mentioned in the **table 1**) with some amount of water (100 ml) to bring the consistency of the developed noodle. The dough was kept for 5-10 minutes. Then make small balls of dough. Take a clean butter paper sheet and put the ball inside it and roll it out with the help of a rolling pin in a circular movement. Make a very thin layer of noodles. Repeat it for the rest of the balls. Cut it with the help of a knife in a line shape, or the desired shape.

Boiling: Then formed noodles were dipped in boiling water for a minute and then remove with the help of a stick, and then sun dry for one day and then the noodle is ready to cook. The steps involved in noodle preparation are illustrated in the picture in **Fig 1** and the varied sample in **Fig 2**.

2.3 Standardization of Food Products

- Quinoa (Chenopodium quinoa),
- Oats (Avena sativa),
- Horse gram (Macrotyloma uniflorum),
- Ficus religiosa

The recipe for noodles was standardized using the following ingredients mentioned in next section 2.4 (**Table 1**).

2.4 Sample variation/Development of the product (noodle)

Powder/flour of Quinoa, Oats, Horse gram, and *Ficus religiosa* was used to prepare a product common in India. Dietary fiber-rich, low glycemic flour was prepared in the amount of 100 grams from the above-mentioned ingredients.

Table: 1 Ingredient used in the preparation of newly developed fiber rich noodles (sample variation)

Experimental products	**Treatments**					
	Ficus religiosa (g)	Quinoa (g)	Horse gram flour (g)	Rolled oatmeal (g)	Wheat flour (g)	Starch (g)
EP1	5	35	10	15	20	15
EP2	10	30	10	15	20	15
EP3	15	25	10	15	20	15
EP4	20	20	10	15	20	15

Steps involve in preparation

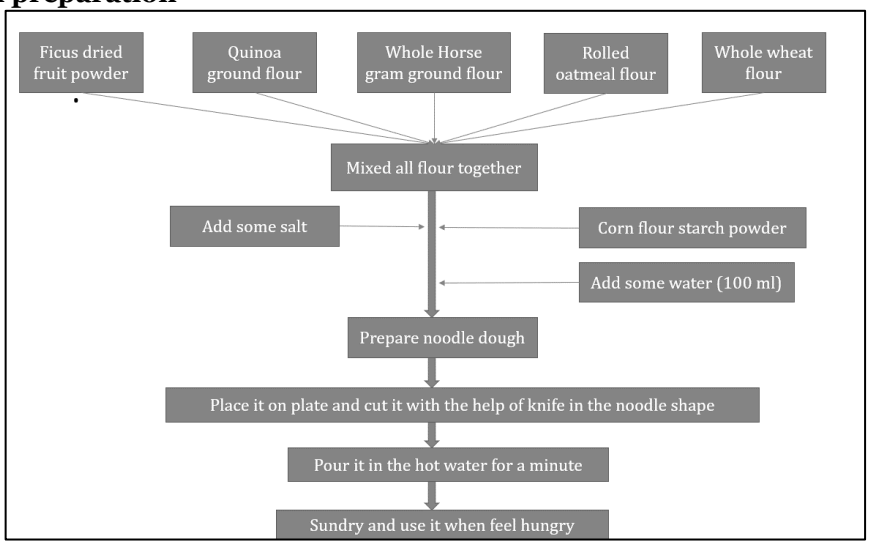


Fig: 1 Steps involve in preparation

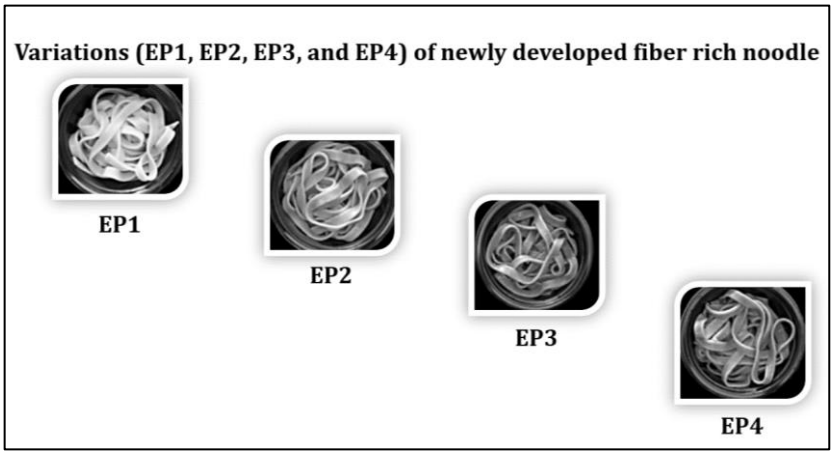


Fig: 2 Images of (EP1, EP2, EP3, and EP4) of newly developed fiber rich noodle

2.5 Sensory Evaluation

Then the sensory evaluation of four samples was done at a point hedonic scale. For each variation, 20 hedonic tastes were conducted by 20 different panelists of Dietetics and Applied Nutrition. Hedonic tastes were done based on Taste, color, texture, Firmness, stickiness, and overall acceptability. Each individual gave their rating based on his likes or dislikes. After conducting the sensory evaluation, a statical analysis was done. The results of the sensory evaluation were explained in the next section 3.1 (**Table: 2**) and **Fig: 3**.

3.Results

3.1 Sensory Evaluation Result

Table: 2 The sensory evaluation of four samples

Attributes	EP1	EP2	EP3	EP4
Taste	9.1 ± 1.2	9.1 ± 1.10	8.8 ± 0.91	7.8±1.68
Colour	9.7 ± 0.67	8.4 ± 1.68	8.7 ± 0.94	7.2±1.54
Texture	9.4 ± 0.51	9.4 ± 0.69	9.4 ± 0.69	7.5±1.84
Firmness	9.5 ± 2.91	8.8 ± 1.13	8.5 ± 1.50	8±2.05
Stickiness	9.5 ± 0.52	8.5 ± 1.26	9.1 ± 0.99	7.3±1.94
Overall Acceptability	9.4 ± 0.51	9.1 ± 0.99	8.9 ± 1.19	7.8±1.81

EP1 as it is clearly seen, containing Ficus powder (5 g), quinoa (35 g), horse gram (10 g) oats (15 g) is rated best among all four samples in terms of overall acceptability (Shown in Figure 3).

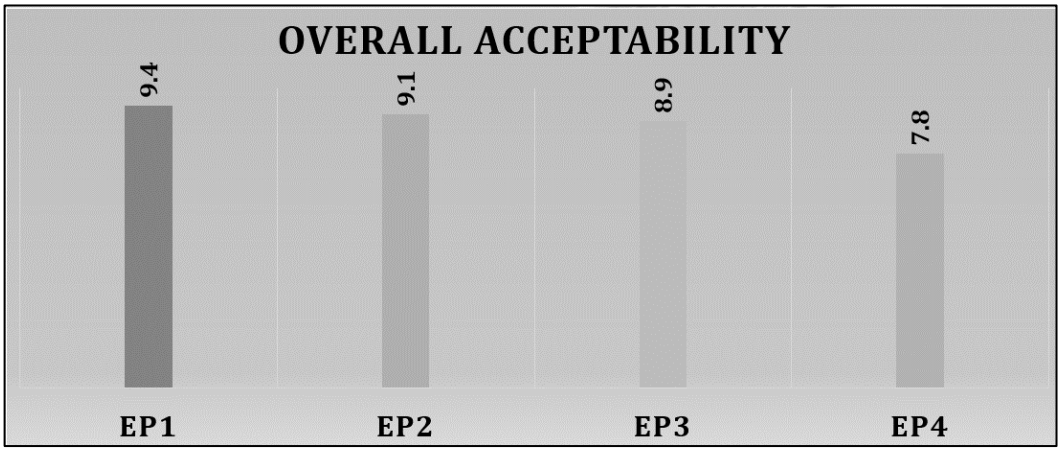


Fig:3 Overall Acceptability

3.2 TOPSIS for Noodle

3.2.1 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).

3.2.2 Analytical Hierarchy Process technique

"Letting the set of the criteria be A= {Aj}, 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: Pair-wise comparison matrix for n number of criteria

K	A_1	A_2.....A_n		
A1	1	a_{12}	a_{13}.....	a_{1n}
A2	a_{21}	1	a_{23}.....	a_{2n}
A3	a_{31}	a_{32}	1.....	a_{3n}
.	.	.	.....	.
An	a_{n1}	a_{n2}	a_{n3}	1

AHP calculation

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

Table 4: 4*4' matrix for four different samples

	A	B	C	D	4^{th} Root	PV (Priority Vectors) Weights
A	1.00	4.00	5.00	6.00	3.31	0.60
B	0.25	1.00	0.33	3.00	0.71	0.13
C	0.20	3.00	1.00	3.00	1.16	0.21
D	0.17	0.35	0.18	1.00	0.32	0.06
Sum	1.62	8.35	6.51	13.00	5.50	
Sum PV	0.98	1.07	1.37	0.76	4.18	

Step 2: After drawing the matrix, the calculation of 4th root was done. 4 th root for A= $(1^* 4^* 5^* 6)^{1/4}$= 3.31; Repeat the steps for all the four variables.

Step 3: After calculating individual 4th root, sum of all the 4th roots were done, which was 5.70 found to be.

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 (eg. 3.31/5.50=0.60). 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= 0.60* 1.62= 0.97; Repeat the steps for all the four variables.

Step 6: Then the calculation of Total for Sum PV= λ(max) {Lambda- max} was done. λ(max)= ∑(PV (A,B,C,D) = 4.18

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

CI= (λ(max) – n)/ (n-1), Where n= number of systems/ variables being compared CI (Consistency Index) = 4.18-4/ 3= 0.06

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 below table.

Table 5: Values of RI

N	1	2	3	4	5	6	7	8	9	10
RI (Random index)	0.000	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Table: Random Consistency Index

In our study, total of 6 criteria were compared, so, n= 6. RI for 6 is used to calculate the CR value. CR= 0.06/ 1.24= 0.048

- The CR is the indicator of the 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 to more than 0.1, then the sample is corrected using various correction measures.
- The calculated Consistency Ratio of the study is 0.05035, which is less than 0.1, so our pair-wise comparison test was found to be consistent, and no corrective actions were required for the comparison.

3.2.3 TOPSIS for Ranking the Samples

Mean scores for all 6 attributes for each sample were used in the TOPSIS method, along with the value of the calculated weights from the AHP method. 6 different attributes used were Appearance, taste, color, flavor, consistency, and overall acceptability.

Table 6: Six different attributes of sensory evaluation

Attributes	**EP1**	**EP2**	**EP3**	**EP4**
Taste	**9.1**	**9.1**	**8.8**	**7.8**
Colour	**9.7**	**8.4**	**8.7**	**7.2**
Texture	**9.4**	**9.4**	**9.4**	**7.5**
Firmness	**9.5**	**8.8**	**8.5**	**8**
Stickiness	**9.5**	**8.5**	**9.1**	**7.3**
Overall Acceptability	**9.4**	**9.1**	**8.9**	**7.8**

Table: 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

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

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

	taste	color	texture	firmness	sickness	Overall	WEIGHTAGE
A	0.522006658	0.56747468	0.52438736	0.544916145	0.549767046	0.920791402	0.59
B	0.522006658	0.49142138	0.52438736	0.504764429	0.49189683	0.199504804	0.14
C	0.504797647	0.50897214	0.52438736	0.487556551	0.526618959	0.322276991	0.21
D	0.447434278	0.42121832	0.41839417	0.458876754	0.422452572	0.09207914	0.06

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

Step 2: Calculation of r_{ij}
To calculate r_{ij} for each attribute, divide the mean score for every attribute by (Σx2 ij) 1/2 for every sample.

Table 8: r_{ij} Values

	taste	color	texture	firmness	Sickness	overall
A	0.307983928	0.33481006	0.30938854	0.321500526	0.324362557	0.543266927
B	0.073080932	0.06879899	0.07341423	0.07066702	0.068865556	0.027930673
C	0.106007506	0.10688415	0.11012135	0.102386876	0.110589981	0.067678168
D	0.026846057	0.0252731	0.02510365	0.027532605	0.025347154	0.005524748

Table: r_{ij} for each attribute

Table 9: Positive and Negative Ideal Situation

V+	0.307983928	0.33481006	0.30938854	0.321500526	0.324362557	0.543266927
V-	0.026846057	0.0252731	0.02510365	0.027532605	0.025347154	0.005524748

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

Step3: Then the Positive and Negative Ideal Solutions are determined.
Positive Ideal Solution is the highest value for each attribute, while the lowest value for each attribute is considered as the Negative Ideal Solution.
Step4: Then the separation from Positive Ideal Solution as well as Negative Ideal Solution is determined-
Si = [S(vj*- vij*)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 the Negative Ideal Solution.
Step5: Then the relative closeness to the ideal solution was calculated using the formula-
Ci = (Si-) / {(Si+) + (Si-)}"

Table 10: Si values and Ci values for each sample. Ranks of different samples.

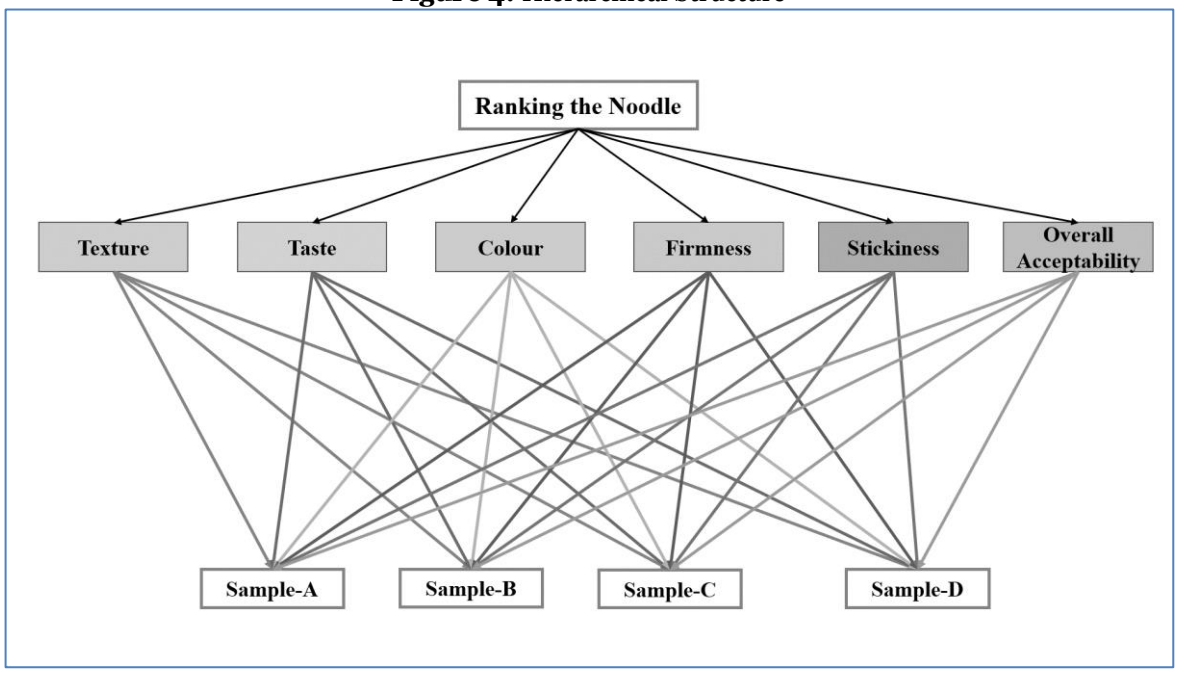
	Si+	Si-	ci	Rank
Sample-A	0	0.848919	1	1
Sample-B	0.758547	0.103066	0.11962	3
Sample-C	0.672567	0.192061	0.222131	2
Sample-D	0.848919	0	0	4

3.2.4 Ranking

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

3.2.5 Hierarchical Structure

Figure 4: Hierarchical Structure



3.2.6 Nutritive composition & values of newly developed product fiber-rich noodle

The food that we eat, should be known about its nutritional composition. The AAC 2005, method was used to calculate the nutritional analysis of the developed product. The carbohydrates, protein, fats, dietary fiber, and energy of the food product were calculated for 100 g samples. The results of the nutritive value of newly developed noodles were described in **Table 11**.
Carbohydrate analysis was done using the Antrone method, the Micro-Kjeldahl method was used for the estimation of proteins, and for the estimation of fats Soxhlet apparatus method was used 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.
Dietary fiber- The Enzymatic-Gravimetric method was used for dietary fiber content calculation.
Crude Fat- The method of fat extraction was followed by AOAC 1995.
Protein Content - Micro Kjeldahl Method The estimation of various flours was done by the Micro Kjeldahl method as described in A.O.A.C. (2000).
The following formula was used: N (%) = 1.4(V2 -V2) Normality of HCI ×250 (dilution)/ weight of Sample
Where, (V2 - V1) = Volume made of the digest
Protein % = N% x Conversion factor (6.25)

Table: 11 Nutritional content of developed noodles

100 gm of noodles contains	
Nutrient	**Amount**
Energy (Kcal)	334.88
Carbohydrate (g)	64.63
Protein (g)	11.33
Fat (g)	3.28
Dietary Fiber (g)	13.27

3.2.7 The nutritional value of newly developed noodles

We found that the newly developed noodle contains more amount of fiber (13.27 g). The calories content of newly developed noodles (334.89 Kcal) and high protein content (11.33 g). The nutritive value is described in Table 11.

Conclusion

EP1 as it is clearly seen, containing Ficus powder (5 g), quinoa (35 g), horse gram (10 g) oats (15 g) are rated best among all four samples in terms of taste, color, texture, firmness, stickiness, and overall acceptability. In view of the findings obtained by the current research, it could be concluded that noodle is good and effective for obese as well as for diabetic patient as they contain a good amount of protein and fiber. The formed noodle was rich in dietary fiber and protein which decreases energy intake and helps to maintain body weight.

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