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NUTRITIONAL AND PHYSICO-CHEMICAL PROFILING OF TRIBULUS TERRISTRIS AND ITS NUTRACEUTICALS APPLICATION

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Abstract:
This study investigates the nutritional, functional, rheological, and sensory properties of flour blends supplemented with varying percentages (2–5%) of Tribulus Terrestris powder. Seeds were collected from the Thall region, dried to <10% moisture, and analyzed for proximate composition, showing high fiber (24.28±0.93%) and carbohydrate (33.35±1.03%) content, with moderate fat (14.49±1.42%) and low protein (8.8±0.30%). Rheological analysis revealed that as Tribulus supplementation increased, moisture content decreased from 14% (control) to 10.1±0.09% at 5%

powder. Water absorption was highest at 5% (59.5±0.05), with maximum dough stability (17±0.09) and development time (4.6±0.09). Maximum kneading consistency was observed at 2% powder. Functional properties, such as bulk density, increased with higher Tribulus percentages, peaking at 83.86±1.36 for 5%. Water absorption capacity reached its maximum in T3 (88.46±0.22), while oil absorption capacity remained non-significant. Foaming stability was significantly higher in T3 (43.78±0.76). Nutritional analysis showed that fiber content increased with supplementation, peaking in T4 (1.49±0.04), while fat and protein contents were non-significant across treatments. Color tonality analysis indicated that lightness decreased with increasing Tribulus content, and hue angle was highest in T1 (77.02±2.68). Sensory evaluation by an expert panel revealed that products with 2% and 3% Tribulus powder had the most acceptable color, taste, and aroma, while higher concentrations resulted in bitterness and darker color. Overall, T1 and T2 were most preferred in terms of sensory quality.

Keywords: *T. terretris*, nutritional composition, rheology, product development, color analysis

Introduction

The nexus of food and nutrition in the century is old and human vitality is dependent on their effectiveness. The last two-century witnessed dreadful (withdrawal) from traditional complementary medicines. Although those were replaced by some synthetic drugs, however, their side effects prompted the stakeholder to rethink their starting. The resulting diet-health linkages get much more attention in the 21st century (Nasri et al., 2014). Thus, expanding the global market to the next highest of around 200 billion US Dollars. Among nutraceutical production, functional food is receiving the highest fair. Globally researcher exploits thousands of plants for their potential to improve human health. However, the success stories were mainly those in use by ancient people since their assumptions. The traditional knowledge held by rural communities played a pivotal role in helping the researchers to achieve some golden mild stones (Pandey et al., 2011).

Plants have a diverse and rich bioactive constituents range which exert numerous bioactivities having propitious health effects on the body of humans. Usually, the plant-derived food consumption is said to be linked with the refined health status as there is reduction in the likelihood of chronic diseases that are non-communicable in nature, like type II DM, cardiovascular diseases, neurodegenerative diseases, and various types of cancers (Télessy, 2019). Henceforth, the plant-based nutraceuticals consumption is invigorated in order to ascertain the human health for peerless management of disease and also its prevention (Gunarathne et al., 2022)

The “nutraceutical” concept was coined to make products with health-protective value readily available which do not need medical consultation. The “nutraceutical” term was ushered by combining “nutrition” and “pharmaceutics” components (Yang, 2021) and is characterized as “more than the food but less than the pharmaceuticals” (Télessy, 2019). The augmented studies of bioactive constituents of multiple plants’ and their physiological effects exertion is being executed in last few years at greater pace than before, which seemingly has been followed by the uprising interest in this research area. Principle reasons for this kind of interest encompasses the increasing trend of these bioactive components usage that are plant-derived in pharmacological and therapeutic health aspects, concepts of emerging health promotion, and growing occurrences of nutritional therapy and phytotherapy implementation (Daliu et al., 2018).

Tribulus terrestris plant is dicotyledonous which comes under the Zygophyllaceae family, that is known commonly as the small caltrops, land caltrops, or puncture vine (Ștefănescu et al., 2020). It abundantly grows in the continent of Asia, Africa, Europe and Australia, and it is also found in sandy soil regions and with arid climate conditions (Zhu et al., 2017). Tribulus. terrestris is being utilized since the ancient times in the conventional medicinal practices of different cultures; Indian Ayurvedic medicine, conventional south-European medicine, and conventional Chinese medicine have all taken benefit from T. terrestris use (Ștefănescu et al., 2020; Reshma et al., 2019). In the conventional Chinese medicine, Tribulus. terrestris is contemplated as exceptional medicine, with its fruits and roots having been utilized for more than hundred of years to treat a various of ailments.

Moreover, the T. terrestris fruits and roots effectiveness in the wide range of disease treatment which is delineated in countries like Pakistan, India and Sudan (Gunarathne et al., 2022). *T. terrestris* in Sudan, is also used to protect or prevent kidney glomeruli (nephritis) inflammation and other inflammatory complications. It is also being utilized in Pakistan as a uricosuric and diuretic (Zhu et al., 2017).

Current study is done to shed a light on the nutritional prospects with respects to its inclusion in various novel food products with regard to ameliorate the potential health debilitation. These studies will further enhance the justification of the usage of T. terrestris in different food products

Material and Methodology:

Sample preparation

The current research project is designed to incorporate the *Tribulus terrestris* to explore its nutritional significance in novel food products. For this purpose, *T.terrestris* samples were collected from urban pretties of tehsil Rangpur district Muzaffar Garh, Punjab Pakistan and samples were dried and packed in air-tight containers for further utilization.

Proximate Analysis

Moisture was determined by using a hot air oven model no (53 LTR NSL – UN55 MEMMERT (GERMANY)). To determine the ash content in the product, the weighted powder was kept on the stove to remove the carbon black after it was placed in a muffle furnace at 550 ±5 ^{0}C. Fiber contents were measured by using the heating mental. In order to perform proximate analysis, take the sample in a digestion conical flask with sulphuric Acid (0.255 N) for acid washing. Placed the flask on heating mental and boil for 30 minutes. After passing from the filter the residues stick with a linen cloth. Wash the residue with distilled water and again transfer it into the digestion flask and add Sodium Hydroxide (base) (0.313 N) for base washing. Again, repeat the process for 30 minutes, and filtration was done. After completing the base washing process, place the residues in the muffle furnace. Weight the ignite content as fiber.

Crude Fat contents in the powder were determined by using n-hexane on the soxhlet apparatus at 80 ^{0}C. Crude Protein content was measured by the Kjlehdhal method by using digestion tablets or a digestion mixture (Copper sulfate, Potassium sulfate, and Ferrous Sulphate with 5:94:1), concentrated sulphuric acid, Boric Acid, Methyl Red. Carbohydrate is a calculated method which was determined by subtracting the moisture, ash, fat, and protein contents from 100.

Functional properties

Functional properties of the flour blend like Bulk density, water absorption, Oil absorption, foaming ability and capacity, Emulsification stability, and activity determined by the following the procedure.

Bulk Density

The ratio between sample mass and volume occupied is called bulk density and is expressed as kg/m^3. Take a 5g sample in a 50 ml cylinder and recorded the net volume of the measuring cylinder (Khan & Saini 2016). Bulk density was calculated by following the formula.

$$\text{Bulk Density} = \frac{wt\ of\ sample}{vol\ of\ sample}$$

Water absorption capacity

The water absorption capacity of flour was measured by the centrifugation method. Take a 3g sample with 25 ml distilled water in pre-weighted falcon tubes. After mixing, centrifuge at 3000 rpm for 30 minutes. After it again gave the stay time for 5 minutes. Again, placed in centrifuged for 30 minutes at 3000 rpm. Collect the supernatant and poured it into a petri-dish and dried it in a hot air oven at 550C for 20 minutes (Kadan et al 2008). Water absorption capacities were expressed as a gram of water bound per gram of the sample on a dry basis

$$\text{Water absorption Capacity} = \frac{(\boldsymbol{wt\ of\ tube\ with\ sample\ after\ drying\ sample\ wt - wt\ of\ tube}) - \boldsymbol{Sample\ wt}}{\boldsymbol{wt\ of\ sample}}$$

Oil absorption capacity

By using the method of Lin et al (1974) oil absorption capacity was determined. Took 5 g sample and mixed with 6ml coconut oil. Stir for 1 minute and gave stay time. After it placed the sample in a centrifuge at 3000rpm for 30 minutes. After that, the extra oil was decanted and the contents of the tube were weighed. OAC was determined as a gram of oil bound per gram of sample (Olu et al 2012).

$$\text{Oil Absorption Capacity} = \frac{\boldsymbol{wt\ of\ tube\ with\ sample\ after\ removing\ oil - (tube\ wt + sample\ wt)}}{\boldsymbol{Sample\ wt}}$$

Foaming Activity and stability

Foaming activity and stability were determined by the method of Kaur and Singh, 2005. Took 1.5 gm sample with 50 ml distilled water in measuring cylinder. Shake the sample vigorously by using a home blender for 2 minutes. The volume of the foam formed was then recorded as the foam capacity (%). A final observation was made after 10 min for recording the foam stability (%).

$$\text{Foaming Capacity (\%)} = \frac{Volume\ after\ whipping - volume\ before\ whipping}{volume\ before\ whipping}$$

$$\text{Foaming Stability (\%)} = \frac{Volume\ of\ foam\ after\ 30\ mint}{initial\ foam\ volume} \times 100$$

Emulsification Activity and stability

Emulsification activity and stability were determined by using the method of Siddiq et al (2009). Took a 0.5g sample with 5 ml distilled water and 5 ml refined coconut oil in a falcon tube. The contents were mixed for 5 min with vigorous shaking. The resulting emulsion was transferred into entrifuge machine and centrifuged at 2000 rpm for 30 min. The ratio of the height of the emulsion layer to the height of the liquid layer was calculated, and the emulsion activity was expressed as a percentage. The emulsion stability was determined after heating the emulsion in a water bath at 80ºC for 30 min, cooling it to 23±1ºC, and centrifuging it at 2000 rpm for 30 min. The emulsion stability expressed as a percentage was calculated as the ratio of the height of the emulsified layer to the height of the liquid layer.

Rheology of the *Tribulus Terrestris* Blend

It is defined as the flow of matter and deformation is called rheology. Dough rheology plays an important role in the quality of products, baking of products, and information about the mechanical behavior of the products (Iuga, & Mironeasa, 2020)

Take a sample on a 14% moisture base with the different percentages of Tribulus powder and placed it into a farinograph bowl. Add the water and mixed to form a dough. Farinograph determines dough and gluten properties measuring by the resistance against the mixing action of blades. Farinographic study about water absorption, dough development time, the moisture level of the flour, weakening of dough, dough stability, and maximum consistency during kneading. Rheology was determined by a Brabander model 8124 farinograph (Brabander OHG, Germany) according to AACC Method at the Rehmat wheat product mill at Ravi Road Lahore.

Product Development

The product was prepared by the supplementation of Tribulus Powder with different percentages of *Tribulus terrestris* powder to determine the nutritional composition of Tribulus Terrestris powder. First oil, butter, and grind sugar mix properly. Add flour, eggs, and cumin powder to the mixture. After adding baking powder and mixing vigorously. Made the four groups according to a treatment plan. In the end, Tribulus powder was added according to the recipe in each group.

Sensory Evaluation

Sensory is an important parameter in the field of food science which deals with the effective response and human sensory perceptions of various kinds of food. The sensory analysis described both quantitative and qualitative characteristics like texture, flavor, color, taste, and aroma by trained panels. By this method of sensory, it is possible to pinpoint differences among products with different percentages of powder and examine relationships between sensory and chemical characteristics. The salty taste is produced by the presence of NaCl, the sweet taste is produced by the presence of carbohydrates, the bitter taste is produced by alkaloids, the sour taste is produced by acid, and the umami taste is produced by the salt of glutamic acid i.e., MSG (monosodium glutamate) Lee et al (2008).

Physical characterization of the product

The textural properties of the product were measured by using a Texture analyzer (TX-700). The hardness of the product was measured by cutting force, using a small three-point bending test rig with a sharp blade cutting probe. The force measured in Nm^{-2} (Klunklin & Savage (2018)).

Results and Discussion

In the first phase, the Tribulus Terrestris seed was collected from a sandy area of Thall. The seeds were dried to reduce the moisture below 10% and stored in an air-locked plastic container. The seeds were analyzed for proximate composition, which showed that plant is a rich source of fiber (24.28±0.93%) and Carbohydrates (33.35±1.03%). Whereas the protein contents were present in a lower amount 8.8±0.30, and fat content was recorded (14.49±1.42%). Results are shown in Table (1).

The findings of (GHULAM DASTAGIR et al 2013) reported higher fiber contents (37.1%) and Carbohydrate contents (33.35±1.03%) in Tribulus Terrestris powder which are not related to the current study but moisture, ash, fat, and protein contents are slightly related to this research work. Results of Fiber contents in the current study slightly agreed with Ghulam *et al* (2013) who recorded (13.7%) fat content.

Table (1): Proximate Analysis of Tribulus Terrestris Powder

Proximate(%)	Moisture	Ash	Fat	Fiber	Protein	NFE
TT	9.65±0.62	9.31±0.37	14.49±1.42	24.28±0.93	8.8±0.30	33.35±1.03

Rheology:

Rheological properties of flour blend with different percentages of Tribulus powder show the different behavior during the processing of the product. All results are statistically highly significant and presented in Table (2). Moisture content decreased by increasing the percentage of Tribulus Terrestris. Moisture contents in control white wheat flour were recorded at 14% and the range of the moisture content % in the Tribulus Terrestris powder blend was recoded from (10.1±0.09 to 11.9±0.05 %). Water absorption is an effect of the moisture level of flour. Maximum water absorption (59.5±0.05) was recorded in 5% Tribulus Terrestris powder and minimum values were recorded in 2% Tribulus Terrestris (57.9±0.09). It was shown that the higher the moisture level, the lowers the water activity. Dough stability depends upon the water absorption in the flour blend. Dough stability directly increased with the percentage of water absorption. Water stability was recorded from 11.48±0.17 to 17±0.09. Dough development time shows the same behavior as dough stability. If dough development time increased, it means it has higher dough stability and water absorption. Dough development time is inversely related to moisture percentage in the flour blend. Maximum development time recorded in 5% powder percentage @4.6±0.09 and minimum values recorded in 2% Tribulus powder 3.5±0.06. Maximum consistency during Kneading (CMAX) is described as the overall scenario during the test. It was recorded maximum in 2% Tribulus powder after control white wheat flour and minimum recorded in 5% powder.

Table (2): Rheological Behavior of Tribulus Terrestris supplemented Flour

Tribulus	Moisture%	WA%	Stability (Min)	DT(Min)	Weakening (UF)	CMAX(UF)
T_0	14.00±0.20^{a}	59.3±0.24^{a}	11.48±0.17^{e}	2.9±0.08^{e}	37.45±1.4^{a}	493.09±10.2^{a}
T_1	11.9±0.05^{b}	57.9±0.09^{d}	12.5±0.05^{d}	3.5±0.06^{d}	23.0±0.059^{b}	491.36±0.05^{b}
T_2	11.6±0.06^{c}	58.4±0.06^{c}	14.±0.06^{c}	4.0±0.07^{c}	15.0±0.066^{c}	484.09±0.06^{c}
T_3	10.4±0.06^{d}	59.0±0.06^{b}	15.±0.06^{b}	4.3±0.07^{b}	13.0±0.066^{d}	478.30±0.06^{d}
T_4	10.1±0.09^{e}	59.5±0.05^{a}	17.±0.09^{a}	4.6±0.09^{a}	11.0±0.099^{e}	472.40±0.09^{e}
F Raito	423**	119**	264**	14990**	11417**	35591**

Functional Properties of Tribulus Terrestris supplemented flour blend

Functional properties of the flour blend for the product describe the behavior of the ingredient during the baking and show affect the finished product in terms of its taste, texture, and mouth feel. Bulk density is an important parameter in the functional property. Results were recorded as statistically significant. Maximum bulk density (83.86±1.36) was recorded in the T_4 treatment in which 5% Tribulus Terrestris powder was added and minimum values (53.75±0.04) were recorded in the T_1 treatment in which the lowest percentage of Tribulus Terrestris 2% added in a fine flour. Results regarding foaming ability were recorded as non-significant.

Results of foaming ability ranged from 38.89±0.84 to 43.54±0.23. Similarly, the results of foaming stability were recorded as highly significant. Foaming stability for T_2 treatment was recorded the same as for T_3 treatment in which 4% Tribulus powder was added. Maximum values were recorded at 43.78±0.76 in the T_3 treatment. Minimum values were recorded in the T_4 treatment in which 5% powder was added. Results for emulsifying ability were highly significant shown in Table (3). Highest values recorded in treatment T_0 followed by T_2, T_1, T_3 and T_4 which were 44.89±0.38, 44.44±1.5, 43.55±1.67, 43.33±1.15 and 39.78±0.76 respectively. Results recorded for foaming ability were statistically non-significant. Maximum values recorded in T_4 treatment 30.91±3.55 and minimum values recorded in T_0 29.86±5.24. The results of water absorption capacity for flour blend with the addition of Tribulus Terrestris were recorded as highly significant. Maximum values calculated in T_3 treatment followed by T_1, T_4, T_2 and T_0 @88.46±0.22, 88.20±12.49, 81.43±2.20 and 44.01±1.40 respectively. The results of oil absorption capacity were recorded as non-significant. The range of OAC was recorded from 68.22±1.37 to 63.00±0.15.

Table (3): Functional Behavior of Flour Blend

TT	Bulk Density%	Foaming%		Emulsifying%		Absorption capacity%	
		Ability	Stability	Ability	Stability	Water	Oil
T_0	80.01±0.33^{b}	40.82±3.86^{a}^{b}	42.67±0.23^{a}	44.89±0.38^{a}	29.86±5.24^{a}^{b}	44.01±1.40^{c}	66.62±2.50^{a}^{b}
T_1	53.75±0.04^{d}	43.54±0.23^{a}	43.33±1.33^{a}	43.55±1.67^{a}	30.40±0.05^{a}^{b}	88.46±0.22^{b}	63.00±0.15^{b}
T_2	77.63±0.54^{c}	43.08±0.28^{a}	43.78±0.38^{a}	44.44±1.5^{a}	31.40±1.67^{a}	81.43±2.20^{b}	65.46±2.09^{ab}
T_3	80.90±1.01^{b}	40.75±0.75^{a}^{b}	43.78±0.76^{a}	43.33±1.15^{a}	25.76±1.31^{b}	105.22±1.14^{a}	68.22±1.37^{a}
T_4	83.86±1.36^{a}	38.89±0.84^{b}	41.33±0.01^{b}	39.78±0.76^{b}	30.91±3.55^{a}^{b}	88.20±12.49^{b}	68.16±3.60^{a}
F Ratio	673**	3.31^{ns}	6.12**	8.42**	1.71^{ns}	47.1**	2.77^{ns}

Nutritional composition of Tribulus Terrestris product.

The nutritional composition of food production is dependent on its nutritional components, moisture, ash, fat fiber protein, and CH_2O. Nutritional components of Tribulus powder-

supplemented biscuits showed variation in results. Maximum values of moisture content recorded in T_3 treatment was 4.89±0.16 followed by T_4, T_3, T_2, T_1 and T_0 @4.85±0.16, 4.76±0.18, 4.74±0.02 and 4.69±0.24 respectively. The results of ash content were recorded as highly significant. The range of ash contents was calculated from 1.01±0.03 to 1.41±0.04. Maximum ash content noted in T_4 which has 5% Tribulus Terrestris powder according to the standard recipe of products.

The ash content recorded in T_3, and T_2 were 1.32±0.05 and 1.25±0.01 respectively. The Control group has a minimum quantity of ash content which was 1.01±0.03. The results of fat contents in the product were recorded as statistically non-significant. Maximum fat was recorded in T_0 @29.97±0.56 and minimum fat content was recorded in T_4 which has 5% Tribulus powder @28.89±1.60. The results of Fiber content in the product were recorded as highly significant. Maximum fiber content showed in T_4 @1.49±0.04 followed by T_3, T_2, T_1 and T_0 1.27±0.02, 1.05±0.01. 0.82±0.01 and 0.34±0.01 respectively. Protein contents were recorded as non-significant in Tribulus Terrestris supplemented product. The range of protein was estimated from 5.66±0.30 to 5.87±0.23. Carbohydrate in the product was also calculated as statistically non-significant. Maximum carbohydrate calculated in T_0 (control) @58.31±0.64 and minimum values calculated in T_4 treatment @57.55±1.98. All results are presented in Table (4).

Table (4): Nutritional composition of supplemented Product

TT%	Moisture	Ash	Fat	Fiber	Protein	CHO
T_0	4.69±0.24^a	1.01±0.03^e	29.97±0.56^a	0.34±0.01^e	5.66±0.30^a	58.31±0.64^a
T_1	4.74±0.02^a	1.17±0.04^d	29.74±0.75a	0.82±0.01^c	5.72±0.28^a	57.81±0.97^a
T_2	4.76±0.18^a	1.25±0.01^c	29.31±0.98^a	1.05±0.01^c	5.82±0.17^a	57.81±0.99^a
T_3	4.89±0.16^a	1.32±0.05^b	29.14±0.79^a	1.27±0.02^b	5.76±0.09^a	57.62±0.73^a
T_4	4.85±0.16^a	1.41±0.04^a	28.89±1.60^a	1.49±0.04^a	5.87±0.23^a	57.55±1.98^a
F Ratio	0.68ns	70.0**	0.64ns	854**	0.37ns	0.19ns

Color Analysis of Tribulus Terrestris supplemented the product

Color tonality of the product important parameter for the acceptance of the product. The chromatic characteristics of the biscuits were studied through the color space composed of L*, which measures the lightness of the samples from 0 (black) to 100 (white); a*, which measures the degree of redness (when positive) or greenness (when negative); and b*, which indicates the yellowness (when positive) or blueness (when negative) of the sample color (Rojo-Poveda et al., 2020). The lightness of the supplemented product decreased with the addition of greenish powder. Maximum light color was recorded in the control group and the highest dark color was recorded in the T_4 treatment in which 5% Tribulus powder was added. Results were statistically highly significant which are shown in Table (5). Color recorded in T_0 was maximum followed by T_1, T_2, T_3, and T_4 @71.32±1.22, 68.90±1.21, 65.77±0.71 and 62.08±2.50 respectively. Results show that light color loss by the addition of green powder. In color tonality a* measures the (– greenness). Maximum green color recorded in T_4 treatment 6.29±2.53 and minimum green color recorded in T_0 followed by T_1 13.84±7.03 and 11.54±2.04 respectively. In color tonality b* shows (yellowness$^+$) and (blueness$^-$). The range of results regarded b* starts at 29.21±1.21 in T_4 and ends in T_0 (45.04±3.23). Results were non-significant in b*. Chroma indicates the saturation of color in the product. In this research work results of chroma were recorded as non-significant. Maximum saturation was observed in T_0 (control) @47.34±5.32 and minimum values were recorded in T_4 treatment which was 29.95±1.14. Hue represents the angle of color tone. The maximum color angle recorded in the T_1 treatment was 77.02±2.68 and the minimum color angle was (71.58±2.77) recorded in the T_4 treatment in which 5% Tribulus Terrestris powder was added. All results are shown in Table (5).

Table (5): Color analysis of product

Treatments	L*	a*	b*	Chroma	Hue
T_0	71.84 ± 7.62^{a}	13.84 ± 7.03^{a}	45.04 ± 3.23^{a}	47.34 ± 5.32^{a}	73.40 ± 6.62^{a}
T_1	71.32 ± 1.22^{b}	11.54 ± 2.04^{ab}	34.52 ± 1.35^{b}	36.43 ± 1.70^{b}	77.02 ± 2.68^{ab}
T_2	68.90 ± 1.21^{b}	9.39 ± 1.53^{bc}	33.02 ± 2.36^{bc}	34.37 ± 1.99^{bc}	74.03 ± 3.37^{ab}
T_3	65.77 ± 0.71^{c}	7.13 ± 1.65^{c}	30.84 ± 2.95^{bc}	31.67 ± 3.04^{cd}	72.72 ± 2.03^{ab}
T_4	62.08 ± 2.50^{d}	6.29 ± 2.53^{c}	29.21 ± 1.21^{c}	29.95 ± 1.14^{d}	71.58 ± 2.77^{b}
F Ratio	46.2**	0.55ns	1.44ns	0.82ns	0.67ns

Sensory Analysis of Tribulus product.

Sensory analysis of the product performed by the expert sensorial panel. The product was prepared with different percentages of supplemented *T. terrestris* powder. In sensory parameter, the panel differentiates color, taste, aroma, flavor, and texture w.r.t control product. Maximum acceptable level of color recorded in 2% and 3% Tribulus product. In 4% and 5% Tribulus products, the color was dark green which was not acceptable by the panel. The taste of the product was very bitter in 4% and 5% supplemented Tribulus Terrestris biscuits. But the taste of 2%, 3% like to control product which was much accepted by the panel. The maximum aroma of the product was recorded in 3% supplemented biscuits. 5% supplemented biscuits recorded muddy aroma which was least accepted by the sensorial panel. All groups recorded the same flavor except for the 5% supplemented Tribulus Terrestris powder product. The texture of the product increased with an increasing percentage of powder products. 5% supplemented Tribulus Terrestris product had recorded maximum texture in the Biscuits. The overall acceptability of the product was recorded by the expert sensorial panel. The panel concluded that after the control group, T_1(2% Tribulus powder), T_2 (3% Tribulus powder), T_3 (4% Tribulus powder), and T_4 (5% Tribulus powder) were recorded as acceptable respectively. All results are represented in Figure 1.

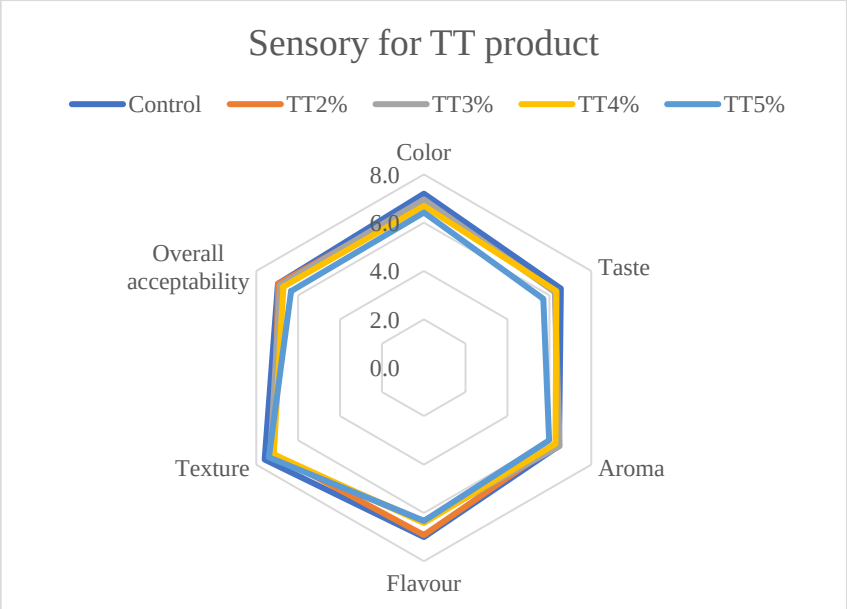


Figure 1 Sensory Analysis of Product

Textural Analysis of Product

The force required to break the texture of the product is called the hardness of the product. It is measured in Nm^{-2}. The hardness of the product was measured by textura Analyser (TX-700). It was observed that hardness increased by increasing the percentage of Tribulus powder. Maximum hardness recorded in T_4 (5% Tribulus powder) which was 2.28 Nm^{-2} followed by TT 4%, TT 3%, TT 2%, and control @ 2.27 Nm^{-2}, 2.07 Nm^{-2}, 1.97 Nm^{-2} and 1.47 Nm^{-2} respectively. All data are represented in graph 2.

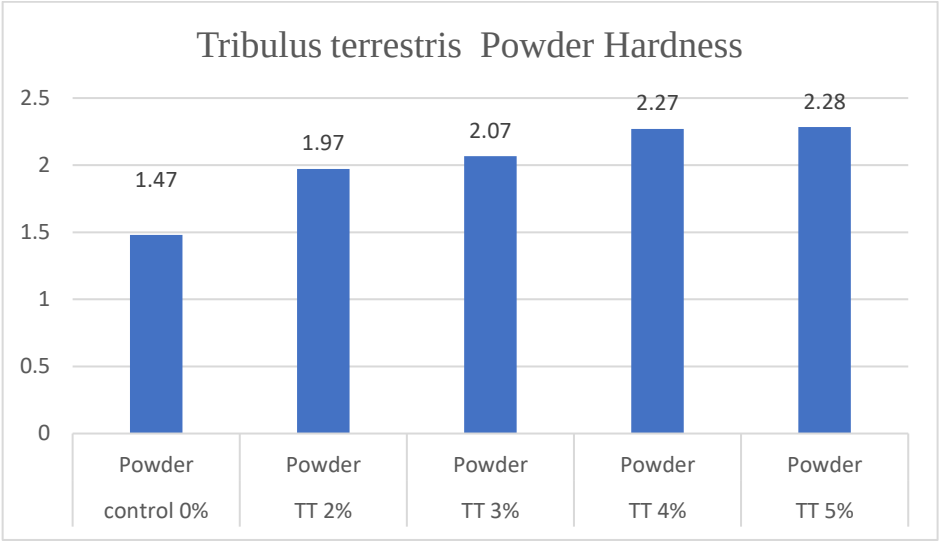


Figure 2: Hardness of Product

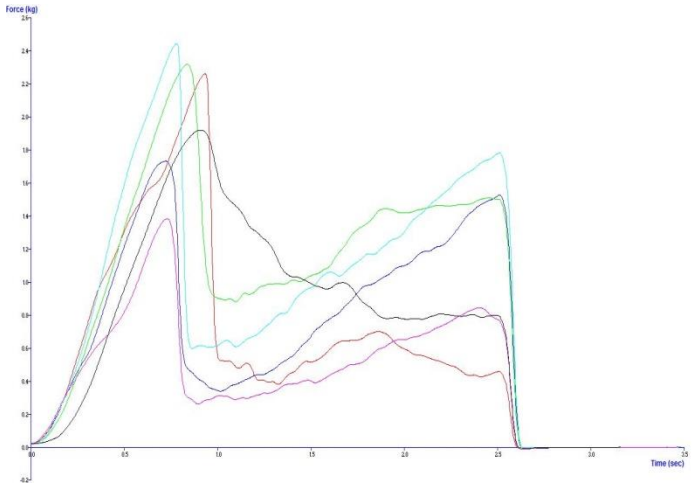


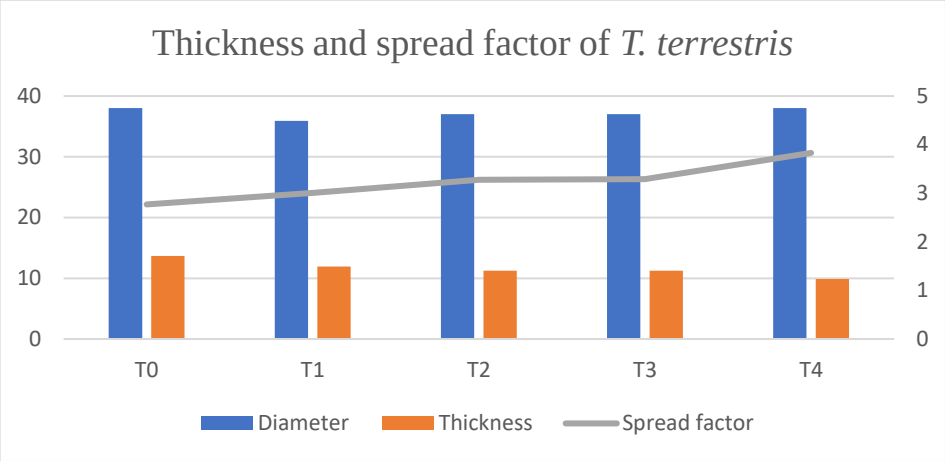
Figure 3: Textural Graph

Thickness and Spread Factor of supplemented product

Thickness and spread factors are the physical parameters of the product. Thickness is measured by micrometer scre-guage measured in mm. The spread factor is the ratio of diameter to thickness of the product that has no units. Results are shown in Table (6). Maximum thickness recorded in T_0 @ (13.67±0.03) with (38.0±0.04) diameter. It was observed that by the addition of Tribulus powder thickness of the product decreased and the diameter of the product increased. Range of thickness recorded from 11.92±0.04 to 9.9±0.09 with the diameter 35.9±0.03 to 38.0±0.02 in Treatment T_2 to T_5 supplemented product. The spread factor depends on the thickness of the product. The spread factor in T_2 powder was recorded 3.01±0.04. It was gradually increased by increasing the percentage of Tribulus powder. In T_5 treatment it was recorded at 3.83±0.01. All the results were statistically significant presented in Table (6).

Table 6: Physical parameter of nutricutical product

Treatment	Diameter	Thickness	Spread factor
T_0	38.0±0.04^a	13.67±0.03^a	2.77±0.02^a
T_1	35.9±0.03^d	11.92±0.04^b	3.01±0.04^b
T_2	37.0±0.04^c	11.25±0.06^c	3.28±0.02^c
T_3	37.0±0.04^c	11.23±0.02^c	3.29±0.02^c
T_4	38.0±0.02^b	9.9±0.09^d	3.83±0.01^d
F Ratio	18.1**	1824**	608**



Graph 3: Graphical representation of Thickness and spread factor

Discussion

The current research project was designed to incorporate the *Tribulus terrestris* to exploit its nutritional significance in novel food products. For this purpose, Tribulus samples were collected from urban pretties of district Layyah, and samples were dried and packed in air-tight containers for further utilization. In the first phase of research,the nutritional quality of Tribulus Terrestris was measured, and results indicated that *Tribulus terrestris* contains a high amount of fiber content and a higher amount of mineral content as indicated in table (1). In the second phase, flour blends were prepared and Tribulus Terrestris was mixed with 2 to 5% and further evaluated for Nutritional composition, functional properties, and Rheological behavior.

The result regarding nutritional composition indicated that with an increment of Tribulus Terrestris there were significant tries in fiber and ash content and the rest of the parameters like protein, fat, and moisture content were affected non-significantly. The increase in dietary fiber and mineral content is a positive sign in current health indicators. Globally, people are consuming low amounts of fiber and minerals and resultantly there is a rise in nutritional and lifestyle disorders. Currently, if we look at the available list of current food products most of them are processed from white wheat flour having an extraction rate of 68 to 72% and which is quite deficient in dietary fiber and minerals contents. Their consumption is the result of that the product prepared from them lacking these ingredients. The addition of *Tribulus terrestris* can provide some pints of these essential nutrients.

In the same phase, the addition of *Tribulus terrestris* further assessed for the impacts on some functional properties. The results were showing that the addition of these novel ingredients enhance the water absorption capacity significantly having appreciable foaming capacity and emulsification capacity while there was a non-significant effect on bulk density and oil absorption capacity. The increase in water absorption was due to the presence of the fibrous compound and normally it is hypothesized that 1 gm of dietary fiber can absorb around 4 to 5 ml of water thus increasing the water absorption capacity by some appreciable amount of fiber contents. Foaming capacity and foaming stability are important parameters in sweet bakery products for example cupcakes, biscuits, and muffins. The addition of *Tribulus terrestris* improves the foaming capacity and stability shows can be used as a functional ingredient in bakery products.

The rheological behavior was studied on Mixolab available at Rehmat wheat mill Lahore. Results indicated that the addition of *Tribulus terrestris* increased the water absorption capacity from 57.9 to 59.5%. However, dough development time and the addition of these novel ingredients result in increased dough development time from 3.5 to 4.6 min. However, the addition of powder was affecting the dough stability time, it increased the percentage of *Tribulus terrestris* powder. The maximum consistency of dough kneading decreased by increasing the powder percentage.

Conclusion:

Concluding all the above findings and discussions it has been determined that Tribulus Terrestris is rich in fiber content and mineral content however proteins, fats, and moisture content affect non significantly. This is nutritionally significant due to having unique combinations to be rich in dietary fibers and rich in minerals both are vital and current needs of humans. It helps to reduce gastrointestinal problems related to health and it puts a good impact on digestion and absorption. The addition of *Tribulus terrestris* in the product increases the water absorption capacity of the product, it has extraordinary foaming capacity and emulsification capacity however it has a very minimal effect on the oil absorption and bulk density. It has been observed that it increases the dough development time as well as it has also increased dough stability. The increased percentage of *Tribulus terrestris* powder affects the dough stability time.

Conflicts of Interest: The authors declare no conflict of interest.

Data Availability: The data that support the findings of this study are available on request from the corresponding author.

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Declaration of Competing Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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