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IMPACT OF BARNYARD MILLET AND DRAGON FRUIT POWDER ON BISCUIT NUTRITIONAL PROPERTIES

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ABSTRACT

The study was carried out at postharvest technology laboratory, College of Horticulture, Mojerla, Sri Konda Laxman Telangana State Horticultural University, Wanaparthy district. This study examines the nutritional properties of biscuits made from composite flour of barnyard millet and dragon fruit powder, focusing on parameters such as moisture, protein, fat, crude fibre, carbohydrates, calcium, iron, calories, phenolic content, and dietary fibre. Moisture content ranged from 2.18% to 3.15%, with lower levels in formulations with higher barnyard millet. Protein peaked at 10.01% in the control sample and decreased with more dragon fruit powder. Ash content increased with dragon fruit powder, reflecting its mineral richness. Crude fibre reached a maximum of 7.65% in formulations with the highest dragon fruit powder, while carbohydrates varied from 63.52% to 70.50%, declining with more dragon fruit. Mineral content, particularly calcium and iron, decreased with added dragon fruit, and caloric content ranged from 414.67 to 491.33 kcal per 100g. Total dietary fibre content varied significantly, peaking at 9.92% in samples with more dragon fruit powder. Overall, biscuits incorporating these ingredients provide enhanced nutritional benefits, especially in dietary fibre, making them valuable for health-oriented consumers. These findings support further development of functional food products that leverage the strengths of barnyard millet and dragon fruit.
***Keywords*:** Crude fibre, Nutritional properties, Barnyard Millet, Dragon fruit powder.

Introduction

Biscuits are popular snacks made from flour, water, fat, and sugar, primarily using wheat flour due to its gluten content. They are cost-effective, have a long shelf life, and come in various sizes and Flavors. Dragon fruit powder is valued for its shelf life and versatility as a natural colorant and functional ingredient. Spray drying transforms fruit juices into nutrient-rich powder that is easy to transport, reducing costs compared to raw fruits, although it may face issues like stickiness, which can be addressed using carrier materials (Kha *et al*., 2010; Tonny *et al*., 2008). Millets, particularly barnyard millet (*Echinochloa frumentacea*), have been consumed for centuries but are declining in use. They are nutrient-dense, high in protein and fibre, low in digestible carbohydrates, and beneficial for metabolic disorders like diabetes (Ugare *et al.,* 2014). Barnyard millet can enhance the nutrient composition of biscuits, especially when combined with dragon fruit flour and peel pectin. Baked goods are favoured for their convenience and long shelf life (Vijaykumar *et al.,* 2013). Their low moisture content reduces spoilage risks, allowing for large-scale production (Dhankar, 2013). Biscuits, in particular, are significant snacks for all ages and efforts are underway to improve their nutritional quality to meet market demands for healthier products (Masoodi and Bashir, 2012). They are made by mixing ingredients into a dough that is baked without fermentation (Lake and Water-Worth, 1980).

Material and Methods

The study was carried out at postharvest technology laboratory, College of Horticulture, Mojerla, Sri Konda Laxman Telangana State Horticultural University, Wanaparthy district, Telangana, India.

Preparation of Dragon fruit powder

In present study the Dragon fruit (*Hylocereus undatus*) firstly was washed and peeled. The fruit flesh was manually cut into thickness of 0.25 to 0.30 mm slices and cut slices were arranged on aluminum foil. The dragon fruit slices were dried at 70°C for 48 h in hot air oven. The dried dragon fruit slices were crushed in a mixer (Preeti Zodoic mixer grinder, 750 Watt) at moderate speed for sufficient time to the particle size 300 mm. Powder was sieved and packed in the airtight bag then stored at 10°C (Yusof *et al.,* 2012) and the process of preparation of dragon fruit flour.

Production of fermented barnyard millet flour

Fine fermented barnyard millet flours were obtained using the modified method of Adebiyi *et al.*, 2017. Approximately 400 g of barnyard millet grains were steeped in 1600 ml of distilled water in a closed container and left to ferment at a temperature of 28^0 C for 24 h. After fermentation period, the water was discarded, and the wet fermented grains were oven dried (40^0 C) for 24 h. After that, the fermented grains were ground into (ZM 200 Miller) flours, which was sieved with 500 mm sieve to obtain the fermented barnyard millet flours.

Treatmental Details

Ingredients (g)	Treatments										
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}
Barnyard Millet flour	100	95	90	85	80	75	70	65	60	55	50
Dragon fruit flour	0	5	10	15	20	25	30	35	40	45	50
Dragon fruit peel pectin	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Note: 30g of butter, 10g of sugar, 3g of salt and 0.5g of baking powder are common ingredients for all the treatments.

Moisture (%)

Moisture and water content are among the most important parameters measured in food as moisture content is inversely related to the dry matter of a food item that directly affects consumers and processors. More importantly, the moisture content in food influences its storage stability and quality. Moisture content of the millet flour and biscuit was estimated as per AOAC (2005) method.

Procedure

The empty Petri dish with a lid was weighed. 2.0 g of flour was weighed into the Petri dish and spread evenly for uniform drying. Oven was set at 105°C, and the Petri dish with the sample was placed inside the oven with lid open for 2 hours, then transferred to a desiccator for cooling. The weight of the petri dish with sample was recorded. The procedure was repeated till constant weight was achieved. Moisture was calculated using the following formula:

$$\text{Moisture}\,(\%) = \frac{(W_2 - W_1) - (W_3 - W_1)}{(W_2 - W_1)} \times 100$$

Where:

W_1 = Initial weight of Petri dish (g)

W_2 = Weight of the Petri dish with sample before drying (g)

W_3 = Weight of the Petri dish with sample after drying (g)

Protein (%)

It was determined by Kjeldahl method (AOAC, 2000). 1 g sample was transferred to a digestion flask to which 5 g of catalyst mixture [9 part of potassium sulphate (K_2SO_4) and one part of copper sulphate ($CuSO_4$)] and 20 ml of concentrated sulphuric acid was added. The content was then digested till transparent liquid was obtained. The digested liquid was allowed to cool and 100 ml distilled water was added. Then it was distilled with excess of 40% NaOH solution and the liberated ammonia was collected in 50 ml of 4% boric acid solution containing 5 to 7 drops of mixed indicator [100 ml of 0.1 per cent methyl red indicator (in 95 % ethanol) + 200 ml of 0.2 per cent bromocresol green (in 95 percent ethanol)]. The entrapped ammonia was titrated against 0.1 N hydrochloric acid. A reagent blank was similarly digested and distilled. Nitrogen content in the sample was calculated as follows and a factor of 6.25 was used to convert nitrogen to protein.

The per cent protein will be calculated by the using following formula:

$$\text{Protein}\ (\%) = \frac{(\text{S - B}) \times \text{N} \times 14.01 \times 100 \times 6.25}{(\text{W})} \times 100$$

where,

S = Volume of standard acid (0.1 N HCl) used for titration (cm^3).

B = Volume of 0.1 N HCl used for blank (cm^3).

W = Weight of sample (g).

N = Normality of acid used for titration (0.1 N HCl).

Ash content (%)

Ash content was estimated by employing the standard method of analysis (AOAC, 2000) using a muffle furnace. The sample was weighed into silica crucible without lid and placed in a muffle furnace at 550 ^{o}C until ashing. It was cooled in a desiccator and weighed with lid. This was repeated until two consecutive weights were constant. The per cent ash content was calculated by on the basis of the initial sample (AOAC, 2000). Ash content will be calculated by using following formula:

$$\text{Ash}\ (\%) = \frac{W_1 - W_2}{W_1} \times 100$$

where,

W_1 = Weight of crucible + Weight of sample before heating (g).

W_2 = Weight of crucible + Weight of sample after heating (g).

W = Weight of sample (g).

Crude Fibre content

The crude fibre content of samples was determined by boiling with 1.25% dilute H_2SO_4, washed with water, and then boiled with 1.25% dilute NaOH. The remaining residue after digestion was taken as crude fibre (AOAC, 2016).

Procedure

1.0 g of moisture and fat free millet flours were weighed and placed in the fibre bags. The glass spacer was kept into the bags. The bags were loaded in the sample carousel at the previewed positions of 1-6. The sample carousel was put into the glass container carefully and added with 500.0 ml of 1.25% dilute H_2SO_4. The glass container axial was boiled for 30 min. The bags were washed by boiling with 500.0 ml distilled water for 30 min and then 500.0 ml of 1.25% NaOH was added and left for another 30 min for boiling. Again 500.0 ml distilled water was added and boiled for further 30 min.

The residue was transferred to an empty crucible and weighed (W1), then dried at 100°C for 4 hours in a hot air oven, transferred to a desiccator for cooling, and weighed (W_2). The crucible was incinerated in a muffle furnace at 600°C for 3 hours. Then crucible was cooled in a desiccator and weighed (W_3).

Calculations

$$\text{Crude Fibre}\ (\%) = \frac{W_2 - W_3}{W_1} \times 100$$

Where,

W_1 = Weight of the sample (g)

W_2 = Weight of the crucible + sample after heating at 100°C (g)

W_3 = Weight of the crucible + sample after incineration at 600°C (g)

W_2-W_3 = Weight of crude fibre (g)

Carbohydrate (%)

Estimation of carbohydrate is by Anthrone method

Reagents Required:

a. 2.5N HCl
b. Enthrone reagent: 200 mg of Anthrone was dissolved in 100 ml ice cold 95%
c. H_2S0_4.
d. Stock Standard glucose solution: 100 mg of glucose was dissolved in 100 ml distilled water (1 mg/ml).
e. Working standard solution: 10 ml of stock standard solution was diluted to 100 ml distilled water.

Procedure

1. Weighed 100 mg of sample and placed in boiling test tube.
2. Hydrolysed by keeping it in a boiling water bath for 3 hrs with 5 ml HCl and cool to room temperature.
3. Neutralize it with solid Na_2CO_3 until the effervescence ceases.
4. Make up volume to 100 ml and then centrifuged.
5. Collect supernatant and take 0.5 ml and 1 ml aliquots were taken.

6. Prepare the standards by taking 0.2 ml, 0.4 ml, 0.6 ml, 0.8 ml, 1 ml and a blank was run simultaneously.
7. Make up the volume in all the tubes to 1 ml with distilled water.
8. Then add 4 ml of anthrone reagent.
9. Heat for 8 min in a boiling water bath.
10. Cool the tubes under water and O.D at wave length at 630 nm was noted.
11. Draw a standard curve by platting concentration of standard on X-axis and absorbance on Y axis.
12. From the graph the amount of carbohydrates present in the sample was calculated. Amount of carbohydrates present = mg of Glucose/ Weight of test sample × 100

Minerals (Calcium and Iron) (mg/100g)

Minerals viz., calcium and iron were estimated using Atomic Absorption Spectrophotometry (AAS) (Savant AA, Australia) (AOAC, 1990: 975.03) whereas calcium using Flame Photometry (AOAC, 1990: 956.01) (BWB BIO)

Wet digestion method was used to estimate minerals. About 0.25 g of flour was mixed with 6 ml of concentrated nitric acid and 1 ml of hydrogen peroxide and equilibrated at room temperature for 20 min, followed by digestion using a microwave digestion system (ETHOS EASY). The segment set was placed in a fume hood until all the fumes disappeared and the solution became light coloured. It was made up to 100.0 ml in a standard volumetric flask with ultra-purified water and filtered using Whatman No. 41 filter paper. The prepared mineral solution was stored at -4°C for further analysis.

Working standards were prepared for all the minerals and fed into the AAS and five channel flame photometers to obtain mineral concentrations. The content of the minerals was gained by using the formula.

$$\text{Element (mg/100g)} = \frac{\text{ppm} \times \text{Volume made up} \times \text{Diln x 100}}{\text{Sample weight}} \times 100$$

Total Phenolic acid (mg/100g)

TPC was determined by the method of Singleton *et al.* (1997), with slight modifications. Extracts (0.5 ml) were mixed with 5 ml of Folin–Ciocalteu reagent (1 mol), neutralized with 4 ml saturated sodium carbonate (75 g L^{-1}), and kept at room temperature for 2 h. Absorbance at 765 nm was measured with a spectrophotometer. TPC was expressed as gallic acid equivalents (mg GAE g^{-1} dry weight).

Results and Discussion

The observations recorded for moisture, protein, fat, crude fibre and carbohydrates of biscuits produced from composite flour of barnyard millet and dragon fruit powder are presented in Table 1 and 2.

1. Moisture (%)

The observations recorded for moisture of biscuits produced from composite flour of barnyard millet and dragon fruit powder are presented in Table 1.

The significant reduction in moisture content was observed during baking operation. The values of moisture content of biscuits ranged from 2.18 to 3.15 %. The biscuits prepared with treatment T_1 (100:0::BYMF:DFP) was showed low moisture content over other treatments. The lowest moisture content was observed in T_1 (2.18 %) treatment followed by T_2 (2.40 %) and highest moisture content in T_{11} (3.15 %) but was at par with T_{10} (3.08 %) treatment. Addition barnyard millet flour in the cookies reduces the moisture content and increase the shelf life of cookies.

The moisture contents of the all the dragon fruit powder incorporated biscuits slightly increased compared to barnyard millet flour biscuits, however the moisture content was within the limit of not more than 10% suitable for stable storage of baked products. Mold growth and moisture dependent biochemical reactions are reduced in low moisture foods on storage. Moisture content above 15% was reported to cause mould growth in foods said by Onimawo and Akubor, 2012.

2. Protein (%)

The observations recorded for protein content of biscuits produced from composite flour of barnyard millet and dragon fruit powder are presented in Table 1.

Protein (%) content of biscuits was significantly influenced by treatments of different proportions of unfermented barnyard flour with dragon fruit powder. It was observed that the maximum protein was recorded with T_1 (10.01 %) but was at par with T_2 (9.82 %), T_3 (9.68 %) and followed by T_4 (9.41 %), T_5 (9.33 %) and minimum protein content was recorded in T_{11} (6.49 %). The low protein content was observed in biscuits incorporated with increasing levels of dragon fruit powder than that of biscuits prepared without dragon fruit powder can be attributed to the lower protein content of dragon fruit than that of barnyard millet. Pawde *et al.* (2020) reported that the protein content decreased (9.10±0.01 to 7.07±0.02 %) with increasing levels of the dragon fruit powder incorporation in biscuit preparation.

Mirsaeedghazi *et al*. (2008) reported that increase of protein in dough causes greater consistency of dough. The interaction including physical and chemical forces among protein molecules play key role on the rheological properties (Shiau and Yeh, 2001). The increase in protein content is acceptable for better rheological characteristics of biscuits.

3. Ash (%)

Table 1 presents the ash content of biscuits made from composite flour of barnyard millet and dragon fruit powder. Significant differences were observed among treatments with varying proportions of the ingredients. The lowest ash content was found in T3 (0.42 %), which was similar to T2 (0.45 %) and T1 (0.48 %). In contrast, the highest ash content was recorded in T11 (1.11 %), closely followed by T10 (1.10 %), T9 (0.88 %), and T8 (0.88 %). The increased ash content in biscuits containing higher levels of dragon fruit powder can be attributed to the mineral richness of dragon fruit compared to barnyard millet. This aligns with findings by Pawde *et al*. (2020), which reported an increase in ash content (from 0.58% to 1.1%) with higher concentrations of dragon fruit powder, a trend also noted by Bharathi *et al*. (2020) in mixed millet cookies.

Table 1 : Data on Chemical Properties of Flours and Biscuits

Treatment	Moisture (%)	Protein (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)	Calcium (mg)	Iron (mg)	Calories (Kcal)	Phenolic (mg GAE/g)
T$_1$ 100:0 (BYMF+DFP)	2.18^{h}	10.01^{a}	0.48^{f}	2.14^{k}	70.50^{a}	19.30^{a}	4.43^{a}	491.33^{a}	0.19^{g}
T$_2$ 95:5 (BYMF+DFP)	2.40^{g}	9.82^{ab}	0.45^{fg}	2.70^{j}	69.42^{ab}	19.42^{a}	4.26^{b}	484.33^{ab}	0.20^{g}
T$_3$ 90:10 (BYMF+DFP)	2.52^{fg}	9.68^{abc}	0.42^{g}	3.10^{i}	68.48^{abc}	18.69^{ab}	4.07^{c}	475.33^{abc}	0.21^{g}
T$_4$ 85:15 (BYMF+DFP)	2.59^{ef}	9.41^{bcd}	0.53^{e}	4.01^{h}	67.81^{abc}	18.33^{bc}	3.94^{c}	467.00^{bc}	0.23^{f}
T$_5$ 80:20 (BYMF+DFP)	2.65^{de}	9.33^{cde}	0.52^{e}	4.66^{f}	67.43^{abc}	18.10^{bc}	3.76^{d}	463.00^{bcd}	0.24^{f}
T$_6$ 75:25 (BYMF+DFP)	2.76^{cd}	9.07^{def}	0.65^{d}	4.33^{g}	66.37^{bcd}	17.90^{cd}	3.62^{d}	455.33^{cde}	0.26^{e}
T$_7$ 70:30 (BYMF+DFP)	2.85^{c}	8.93^{ef}	0.72^{c}	5.53^{e}	65.50^{cd}	17.59^{cd}	3.38^{e}	443.67^{def}	0.27^{e}
T$_8$ 65:35 (BYMF+DFP)	2.86^{c}	8.70^{f}	0.88^{b}	5.92^{d}	65.53^{cd}	17.24^{de}	3.14^{f}	434.00^{efg}	0.31^{d}
T$_9$ 60:40 (BYMF+DFP)	3.01^{b}	8.05^{g}	0.88^{b}	6.49^{c}	63.58^{d}	16.79^{e}	2.92^{g}	424.33^{fg}	0.33^{c}
T$_{10}$ 55:45 (BYMF+DFP)	3.08^{ab}	7.80^{g}	1.10^{a}	7.22^{b}	63.52^{d}	16.63^{e}	2.85^{g}	420.00^{g}	0.35^{b}
T$_{11}$ 50:50 (BYMF+DFP)	3.15^{a}	6.49^{h}	1.11^{a}	7.44^{a}	63.59^{d}	15.69^{f}	2.65^{h}	414.67^{g}	0.38^{a}
Mean	**2.73**	**8.85**	**0.70**	**4.87**	**66.52**	**17.79**	**3.55**	**452.09**	**0.27**
S.E.m.±	**0.04**	**0.15**	**0.01**	**0.07**	**1.1**	**0.26**	**0.05**	**7.91**	**0.01**
C.D. 5%	**0.12**	**0.45**	**0.04**	**0.19**	**3.22**	**0.76**	**0.15**	**23.21**	**0.01**
C.D. 1%	**0.17**	**0.62**	**0.06**	**0.26**	**4.38**	**1.03**	**0.2**	**31.54**	**0.02**

4. Crude Fibre (%)

The crude fibre content of biscuits, shown in Table 1, was significantly affected by the varying proportions of barnyard millet and dragon fruit powder. T11 recorded the highest crude fibre content at 7.65 %, comparable to T10 (7.37 %) and T9 (7.24 %). The lowest was noted in T1 (2.37 %). Both barnyard millet and dragon fruit are high in fibre, so increasing their proportions in the biscuits correspondingly increased fibre content. This indicates that biscuits made with a combination of these flours are a rich source of crude fibre. Pawde *et al*. (2020) reported similar results, noting an increase in crude fibre content from 4.96% to 8.42% with higher dragon fruit powder inclusion. Anju and Sarita (2010) also found that crude fibre content in barnyard millet biscuits was significantly higher than in refined wheat flour biscuits, demonstrating the nutritional benefits of incorporating barnyard millet into various foods.

5. Carbohydrate (%)

Table 1 summarizes the carbohydrate content of biscuits produced from composite flour of barnyard millet and dragon fruit powder. The carbohydrate content varied significantly, ranging from 63.52 % to 70.50 %. T1 exhibited the highest carbohydrate level at 70.50 %, followed by T2 (69.42 %), T3 (68.48 %), T4 (67.81 %), and T5 (67.43 %). The lowest carbohydrate content was found in T10 (63.59 %), which was similar to T11 (63.52 %) and T9 (63.58 %). As the percentage of dragon fruit powder increased, the carbohydrate content decreased, likely due to dragon fruit powder's lower carbohydrate content (Ayo-Omogie & Ogunsakin, 2013; Silky & Tiwari, 2014). The observed carbohydrate levels align with ranges reported by Silky & Tiwari, 2014) Variations in carbohydrate content may also be influenced by changes in other constituents like protein, fat, ash, fibre, and moisture (Akpapunam *et al*., 1996). who noted higher carbohydrate values in cookies made with composite flours compared to those without.

6. Calcium (mg)

Table 1 presents the calcium content (mg/100g) of biscuits made from composite flour of barnyard millet and dragon fruit powder. Significant differences were observed across treatments with varying proportions of the ingredients. Treatment T2 showed the highest calcium content at 19.42 mg/100g, closely followed by T1 (19.30 mg/100g) and T3 (18.69 mg/100g). The lowest calcium level was found in T11 (15.69 mg/100g). The decrease in calcium content with higher levels of dragon fruit powder is attributed to its lower calcium content compared to barnyard millet flour (Pawde *et al.*, 2020), as millets generally have higher calcium levels than fruits (Verma *et al.*, 2014).

7. Iron (mg)

Table 1 also details the iron content (mg/100g) in the biscuits. The treatments significantly influenced the iron levels, with T1 recording the highest at 4.43 mg/100g, followed by T2 (4.26 mg/100g) and T3 (4.07 mg/100g). The lowest iron content was noted in T11 (2.65 mg/100g). Similar to calcium, the iron content decreased with higher incorporation of dragon fruit powder due to its lower iron levels compared to barnyard millet flour (Pawde *et al.*, 2020), supporting findings by Verma *et al.* (2014) and Hemalatha *et al.* (2006).

8. Calories (kcal)

The calorific value of the biscuits, shown in Table 1, ranged from 414.67 to 491.33 kcal/100g across different treatments. The highest calorie content was observed in T1 (491.33 kcal), which was similar to T2 (484.33 kcal) and T3 (475.33 kcal). In contrast, T11 recorded the lowest caloric value at 414.67 kcal, similar to T10 (420.00 kcal) and T9 (424.33 kcal). The decrease in caloric content with increased dragon fruit powder is attributed to its naturally low-calorie nature, primarily deriving calories from carbohydrates. The caloric range aligns with reports from Adeyeye and Akingbala (2015). Bharathi *et al.* (2020) found similar caloric values in mixed millet cookies, highlighting a significant increase in calorific value during baking.

9. Phenolic (mg GAE/g)

The phenolic acid content (mg) in the biscuits, influenced by varying proportions of barnyard millet and dragon fruit powder, is presented in Table 1. Among the treatments, T11 recorded the highest phenolic content at 0.38 mg, followed by T10 (0.35 mg) and T9 (0.33 mg). The lowest was in T1 at 0.19 mg. The total phenolic content increased proportionally with higher dragon fruit powder incorporation, consistent with findings from other studies on fruit additives and their effects on phenolic levels in baked goods.

In present study the Dragon fruit (*Hylocereus undatus*) firstly was washed and peeled. The fruit flesh was manually cut into thickness of 0.25 to 0.30 mm slices and cut slices were arranged on aluminum foil. The dragon fruit slices were dried at 70°C for 48 h in hot air oven. The dried dragon fruit slices were crushed in a mixer (Preeti Zodoic mixer grinder, 750 Watt) at moderate speed for sufficient time to the particle size 300 mm. Powder was sieved and packed in the airtight bag then stored at 10°C (Yusof *et al.,* 2012) and the process of preparation of dragon fruit flour.

Table 2 : Data on Fiber analysis of biscuits

Treatment	Total dietary fibre (TDF, %)	Soluble dietary fibre (SDF, %)	Insoluble dietary fibre (IDF, %)
T_1 100:0 (BYMF+DFP)	8.98^{e}	2.57^{d}	6.14
T_2 95:5 (BYMF+DFP)	9.17^{de}	2.59^{d}	6.19
T_3 90:10 (BYMF+DFP)	9.29^{cde}	2.62^{cd}	6.25
T_4 85:15 (BYMF+DFP)	9.38^{bcd}	2.69^{cd}	6.28
T_5 80:20 (BYMF+DFP)	9.38^{bcd}	2.74^{bc}	6.34
T_6 75:25 (BYMF+DFP)	9.47^{bcd}	2.62^{cd}	6.37
T_7 70:30 (BYMF+DFP)	9.59^{abc}	2.84^{ab}	6.43
T_8 65:35 (BYMF+DFP)	9.66^{abc}	2.89^{a}	6.44
T_9 60:40 (BYMF+DFP)	9.72^{ab}	2.93^{a}	6.50
T_{10} 55:45 (BYMF+DFP)	9.73^{ab}	2.32^{e}	6.52
T_{11} 50:50 (BYMF+DFP)	9.92^{a}	2.97^{a}	6.67
Mean	**9.48**	**2.71**	**6.38**
S.E.m.±	**0.13**	**0.05**	**0.1**
C.D. 5%	**0.37**	**0.14**	**NS**
C.D. 1%	**0.5**	**0.18**	**NS**

2. Soluble Dietary Fiber (SDF, %)

The soluble dietary fiber (SDF, %) content of the biscuits, influenced by different treatments of barnyard millet and dragon fruit powder, is shown in Table 2. Treatment T10 had the highest SDF at 2.97%, which was similar to T9 (2.93%), T8 (2.89%), and T7 (2.84%). The lowest SDF was recorded in treatment T11 at 2.32%.(Table 2).

3. Insoluble Dietary Fiber (IDF, %)

Table 2 also presents the insoluble dietary fiber (IDF, %) data for the biscuits. Significant differences were noted across the various treatments. Treatment T11 exhibited the highest IDF at 6.67%, followed by T10 (6.52%) and T9 (6.50%). The lowest IDF value was in treatment T1 at 6.14%.

Insoluble dietary fibers primarily consist of lignin, cellulose, and some hemicelluloses, while soluble fibers include pectins, pentosans, β-glucans, and gums. Soluble fibers can be viscous or non-viscous and are fermentable, which can reduce their amount in the biscuits during fermentation. In contrast, insoluble fibers are typically non-viscous and poorly fermented, leading to a notable decrease in their levels in the biscuits made from fermented barnyard millet and dragon fruit powder.

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