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Effect of Incorporation of Foxtail Millet for Preparation of Dosa Breakfast Mix and Comparison with the Traditional Dosa Mix

P. Mounika[1*], G. Gnanashree[1], P. Sangeetha[1], A. Tejaswini[1] and Samreen[2]
[1]College of Food Science and Technology, PJTS Agricultural University, Rudrur, (Telangana), India.
[2]Assistant Professor, Department of Food Process Engineering, College of Food Science and Technology, PJTS Agricultural University, Rudrur, (Telangana), India.

(Corresponding author: P. Mounika)*
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ABSTRACT: Foxtail millet (*Setaria italica* L.) is one of the ancient crops that are largely grown in semi-arid and arid climatic regions of Asia, Africa and India. Foxtail millet consists of prominent levels of fiber, mineral, protein, phytochemicals and other bio-active compounds. Inspite of the nutritional benefits of foxtail millet, the consumption of this millet is less. The present study was conducted to formulate nutritious rich millet dosa mix and comparison of the biochemical composition and sensory qualities of those with traditional rice-based dosa mix. The present study concentrated in the area of value addition to millets. Dosa breakfast mix was developed by incorporation of raw foxtail millet at different levels (25%, 35%, 40% and 50%) and cooked dosa. The dosa prepared were subjected to analysis. Dosa prepared by incorporating Foxtail millet recorded values as protein (14–15%), fat (5–9%), ash content (2–3%) and crude fibre (2–4%). The results obtained for dosa prepared by incorporation of millets, recorded high values where as traditional dosa recorded as fat (1.89%), ash (2.05%), protein (6.6%), crude fibre (1.42%). During the different processing steps involved in preparation of dosa, fermentation evidently decreased the tannin content when millets were incorporated in dosa mix. Overall acceptability in sensory evaluation revealed that millet based products were liked moderately. The study revealed that the dosa prepared by incorporation of millets was nutrition rich when compared to the traditional dosa. It was also observed that the processing procedures used were capable of removing anti-nutritional factors.

Keywords: Protein, crude fibre, proportion, dietary values, anti-nutrients.

INTRODUCTION

Cereals are the members belonging to the grass family, consisting of long thin stalks cultivated for starchy component present in them. Certain examples of cereals are rye, maize, rice, sorghum, millet, wheat and barley are usually used as staple food (Anju and Sarita, 2010). Cereals are consumed a lot and it plays an important role in human diet. Among cereals minor millets that contribute a lot to the potential health benefits and national food security. Cereals are considered to be staple food as they are cultivated in sustainable manner and are superior in energy content when compared to other crops. Cereals are not only consumed by humans but also used as cattle feed because of their nutritional benefits. Further which are eventually rendered as meat, dairy and poultry products for human consumption. They are also used industrially in the production of substances, such as glucose, oils and alcohols (Brigid, 2004).

Millets, commonly known as coarse cereals are extensively grown in India. Millets are considered to be ancient crops grown, that are originated from Africa. Millets are the staple food crops consisting of long stalk bearing starchy edible grain. Consumption of millets as staple food was actually restricted to India, Korea and China. But now millets are consumed different parts of the world because of their nutritional benefits. Millet grains are attracting attention in developing countries not only in terms of utilization as food but also for manufacturing of bioethanol and biodegradable films.

Nutritional requirements for humans are changing from day-to-day in order to make bodies resistant to many diseases. In connection to this, the daily intake of dietary supplements is varied from person to person depending upon their inherent body nature. Due to this there was more consciousness regarding selectivity of food supplements which led to the increased consumption of millets. The preferential requirements for selective intake of food to prevent the increase in body weight also led to use of millets. Millets are the cheapest source of energy when compared to rice and are widely consumed by rural section in many parts of India (Krishnamoorthy *et al*., 2013).

In recent years, minor millets have turned to be the best source of nutrition and health. These minor millets constitute major portion of consumption today in many households that led to prevent the situation of food starvation. This also helped to meet the needs of increasing population growth. Though foxtail millet has better nutritional qualities when compared to other millets, as they are rich in minerals, vitamins, phytochemicals etc, the research conducted is meagre (Rachie, 1975).

Foxtail millet is cultivated in China and India, but is also produced on a smaller scale in South Korea, North Korea, Japan, Russia, Australia, France and the United States for human food, stock feed or industrial uses. Foxtail millet has some important characteristics such as high water use efficiency and drought resistance, tolerance to soil of low nutrient availability, strong adaptability and good yield stability (Lu *et al*., 2015). It was once regarded as more important than rice, wheat and beans (Ketki *et al.,* 2017).

The foxtail millet is rich in protein, fat content and crude fibre. Also the foxtail millet is rich in B-complex vitamins like thiamine, minerals especially P, Ca and Fe, certain amino acids like methionine, threonine and is low in phytic acid which makes them staple crop when compared to rice (Chandra and Selvi, 2016, Gopalan *et al*., 2004; Chavan and Kadam, 1989).

Foxtail millet has large health benefits like efficient functioning of heart, curing dementia, increase in remembrance power, antioxidants, functioning of brain etc (Hemalatha *et al.,* 2016). Varied processing techniques were used for development of value added products like cakes, breads, extruded products, popped and flaked products, baby foods etc (Simango, *et al.* 1997).

India has a versatile culture heritage of traditional food. In the present days the traditional food is transformed with addition of nutritional aspects and made available to consumer on commercial scale. The traditional foods alone occupy large portion of meal as they are rich in vitamins, proteins, carbohydrates satisfying the nutritional requirements of human beings. Some of the conventional foods include Uttapam, Dosa, Naan, Litti Chokha, Kefir, Idli, Dokhla, Chole Bhature etc (Gopalan *et al*. 2004). Most of traditional delicacies preparation included the prominent step, fermentation. Fermentation is the process where the raw materials are subjected to microbial activity to produce required biochemical reactions leading to altering the quality of final food products. Fermented foods are rich in proteins and amino acids which make them always superior to the common cooked foods. Fermented foods have higher nutrition and digestibility. Fermentation process has always played the role in lowering the anti-nutritional factors like tannin and phytic acid in the food grains. Natural fermentation induces phytate hydrolysis through the action of microbial phytase enzymes originating from the micro flora on the surface of cereals and legumes, thereby reducing the phytate. Fermentation of a batter of cereal-pulse combination in the preparation of dosa enhanced the protein quality and the bioavailability of minerals (Tamang, 1998; Steinkraus, 1997). Conventional fermented foods prepared from different types of cereals are very common in various parts of the world. In South India, Dosa is consumed as breakfast which is a rice-based thin layered pancake from fermented batter of rice and lentils which are known as traditional fermented foods (Reddy and Salunkhe, 1980).

The cereals and pulses are consumed in traditionally fermented foods which are enriched by legumes. Legumes are high in proteins that can be used as supplement for amino acids that are deficient in cereals. Hence the fermented foods are predominant in nutrients. Value addition of fermented foods can be done by addition of millets which are high in minerals like potassium, iron, magnesium and phosphorus. But utilization of millets is limited because of the presence of anti – nutrients like phenols, tannins and enzyme inhibitors.

Keeping all this in view, an attempt has been made in this study to develop traditional breakfast product, dosa of nutritive value by incorporation of Foxtail millet. The present study has been proposed with the following objectives was to develop a process technology for preparation of Foxtail millet based breakfast mixes, to optimize the proportions of rice flour, black gram and foxtail millet, to compare the traditionally prepared and millet based products, to study the proximate and sensory characteristics of developed products.

MATERIAL AND METHODS

The raw materials Foxtail millet (FM), rice, black gram etc were purchased from local market. They were cleaned, sorted and subsequent operations for preparation of dosa was performed. In the present study, preparation of dosa was performed by incorporation of Foxtail millet in the breakfast mix.

Preparation of Breakfast mixes. Breakfast mixes were developed by incorporation of Foxtail millet in the traditional recipes. The Foxtail millet was substituted at different levels as shown in Table 1.

For Dosa mix: Raw FM, Rice flour, Black gram Dosa breakfast mixes developed with addition of different levels of Foxtail millet were cooked. The prepared dosa were subjected to physicochemical analysis and sensory evaluation. The procedure for preparation of dosa was shown in Figs. 1 and 2.

Table 1: Different treatments in preparation of FM based Dosa mix.

Product	Ingredients used(g)				
	Black gram	Rice flour	Foxtail millet	Salt	Sodium Bicarbonate ($NaHCO_3$)
Control Dosa	25	50	-	2	2
T_1	25	25	25	3	2
T_2	15	10	50	3	2
T_3	50	-	25	2	2
T_4	25	-	50	3	2

Methodology for preparation of traditional dosa

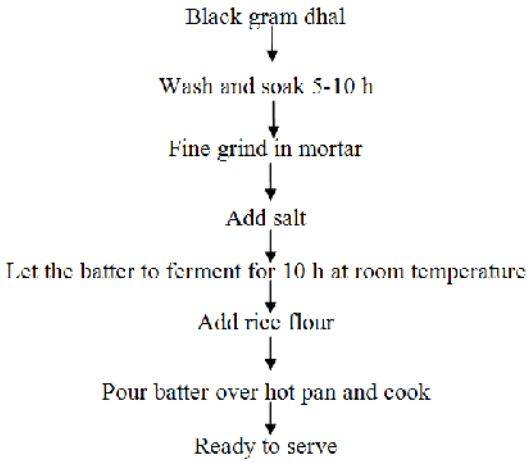

Fig. 1. Flowchart for preparation of traditional dosa.

Methodology for preparation of millet based dosa

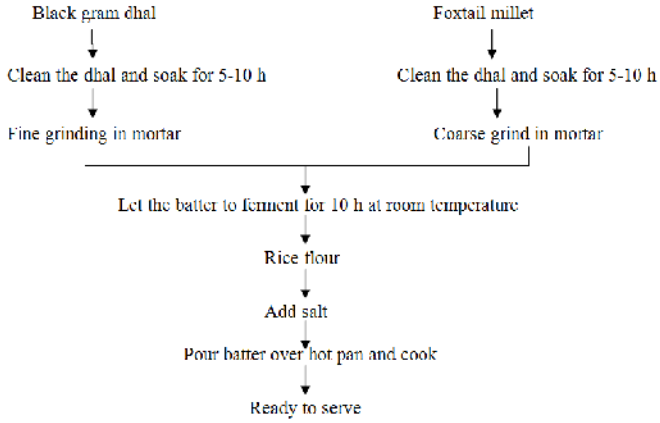

Fig. 2. Flow chart for preparation of millet based dosa.

I. Determination of physicochemical analysis

The following physicochemical analysis was conducted for dosa prepared with addition of different levels of Foxtail millet as shown in Table 1.

1. Moisture content. The moisture content of the dosa prepared with different treatments was analysed. Determination of moisture content was performed by the method of AOAC (1990).

Moisture content (%) =

$$\frac{(w_2-w_1)-(w_2-w_3)\times 100}{(w_2-w_1)}$$

Where;

W_1 = Initial weight of the empty petridish (g)

W_2 = Weight of the petridish + sample before drying (g)

W_3 = Weight of the petridish + sample after drying (g)

2. Protein content. Protein content was analysed for the dosa prepared by incorporation of Foxtail millet and for the dosa prepared by traditional process. The protein content was determined by Lowry's method.

3. Fat content. Fat content was evaluated for the dosa prepared with different levels of treatments. The fat content of dosa prepared with different treatments was evaluated using the method of AOAC (1990).

Fat content =

$$\frac{Weight\ of\ ether\ extract\ (g) \times 100}{Weight\ of\ the\ sample\ (g)}$$

4. Crude fibre

Crude fibre was analysed for the dosa prepared by incorporation of Foxtail millet and for the dosa prepared by traditional process. The crude fibre was determined using the procedure of AOAC (1990).

Crude fibre =

$$\frac{(100 - (moisture + fat))x\ A\ x\ 100}{W1}$$

Where; W_1 = Weight of the dosa sample

W_2 = Weight of the crucible + dosa sample before heating at 600°C

W_3 = Weight of the crucible + dosa sample after heating at 600°C

W_2–W_3 = A = Weight of Crude fibre

5. Ash content. The ash content of the dosa prepared with different treatments was analysed. Determination of ash content was performed by the method of AOAC (1990).

Weight of the dosa sample taken = $W_2 - W_1$ g

Weight of the ash obtained after process = $W_3 - W_1$ g.

Ash content =

$$\frac{Weight\ of\ Ash \times 100}{Weight\ of\ sample}$$

or

$$\frac{(w_3 - w_1) \times 100}{(w_2 - w_1)}$$

II. Sensory evaluation. Sensory evaluation of the different samples of dosa prepared was conducted with ten untrained panel members selected from the students of CFST, Rudrur. A score card was prepared and handed over to the panellists keeping in view the sensory quality attributes like colour, texture, taste, flavor and overall acceptability. Scores were assigned to each sensory attribute according to nine point Hedonic scale.

RESULTS AND DISCUSSION

In the present study, dosa breakfast mixes were developed by substitution of Foxtail millet at different levels including with black gram and rice flour. The products prepared were subjected to physicochemical analysis and sensory evaluation. The results obtained from the analysis were explained.

A. Physicochemical Analysis of Dosa Prepared with Different Treatments

1. Changes in moisture content of dosa. Analysis of moisture content of different samples of dosa incorporated with foxtail millet and traditional dosa sample was performed (Fig. 3). It was revealed that moisture content of control was high when compared with the other treatments. The moisture content of the samples consisting of rice flour i.e., T_1 and T_2 decreased. Similarly, the samples with no addition of rice flour i.e., T_3 and T_4 also decreased. But there was increase in moisture content values in treatments T_2 and T_3. Among the treatments the high moisture content observed for T_1 i.e. 26.71% and low moisture content observed for T_2 i.e. 25.1%. Slight change in moisture content was observed for treatments T_2 and T_4 i.e. 25.1% and 25.12%, respectively.

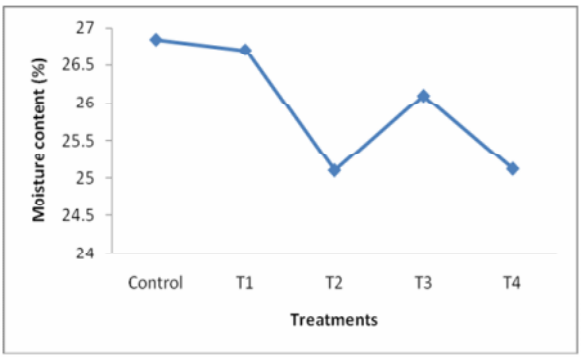

Fig. 3. Variation of moisture content upon different treatments in Dosa.

Moisture content of control sample was observed high when compared with the treatment because black gram and rice flour having high moisture content than foxtail millet. The moisture content of T_1 was high as black gram and foxtail millet were in equal proportion. Slight variation was found between T_2 and T_4 because the foxtail millet content was decreased and black gram content was increased among the treatments. The results obtained were in accordance with Krishnamoorthy *et al.* (2013) for Dosa prepared from Foxtail Millet Dosa mixes. Suman *et al.* (2015) quoted the results of comparision of moisture contents of foxtail millet and rice which represented that foxtail millet had lower moisture content than rice. This explains the decrease in moisture content of dosa prepared by incorporation of foxtail millet. Suman *et al.* (2015) also revealed the similar results.

2. Changes in fat content of dosa. The fat content of control was found low when compared with the treatments (Fig. 4). The fat content consisting of rice flour i.e., T_1 and T_2 was increased. Similarly, the samples with no addition of rice flour i.e., T_3 and T_4 also increased. However, the fat content decreased for the treatments, T_2 and T_3. Among all the treatments the highest fat content was observed for T_4 i.e. 8.5 % and lowest fat content was observed for control sample i.e. 1.89 %. Slight change in fat content for T_2 and T_4 i.e. 8.12 % and 8.5 %, respectively.

The fat content of control was observed low when compared with the treatment because black gram and rice flour having low fat content than foxtail millet. The fat content of treatment T_1 was also low because the black gram and foxtail millet were in equal proportion. Slight variation was found among T_2 and T_4 treatments because the foxtail millet content was decreased and black gram content was increased among the

treatments. Krishnamoorthy *et al*. (2013) reported similar results for dosa prepared from foxtail millet dosa mixes. Suman *et al.*, (2015) also revealed that the different products formulated with foxtail and barnyard millet were higher in fat content than the rice products.

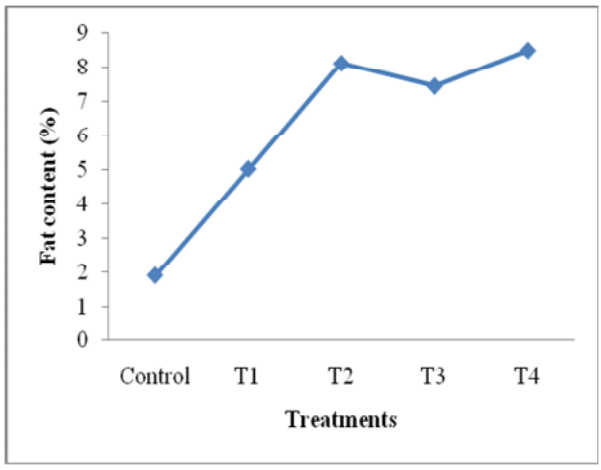

Fig. 4. Variation of fat content upon different treatments in dosa.

3. Changes in ash content of dosa. The ash content of different samples was analyzed and represented as shown in Fig. 5. It was observed that ash content increased in all samples except T_3. The ash content of control sample was found lowest when compared with all the other treatments. Among the treatments the highest ash content was observed for T_4 i.e. 2.7 %. Slight change in ash content was recorded for treatments, T_2 and T_4 i.e. 2.5 % and 2.7 %, respectively. It was observed that ash content generally increased for treatments, T_1 and T_2. Similarly it was also observed for treatments, T_3 and T_4 (Fig. 5).

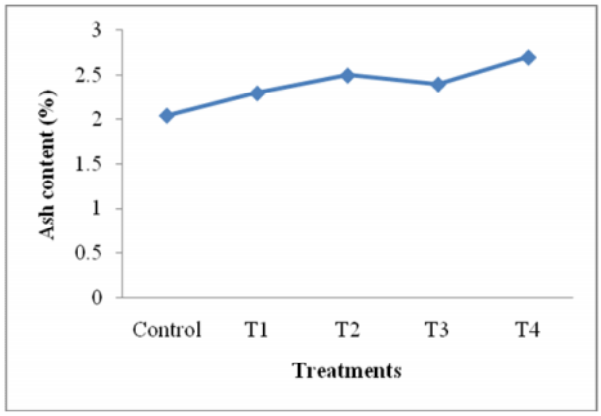

Fig. 5. Variation of ash content upon different treatments in dosa.

The ash content was observed to be low for control sample when compared with the other treatments because black gram and rice flour have low ash content than foxtail millet. The ash content of treatment T_1 was also low among the treatments as black gram and foxtail millet were in equal proportion. Slight variation between treatments, T_2 and T_4 was observed because of the difference in proportions of foxtail millet and black gram contents. The results obtained were in accordance with Krishnamoorthy *et al*. (2013) for Dosa prepared from Foxtail Millet Dosa mixes. Ketki *et al*. (2017) revealed that in preparation of upma mix with incorporation of foxtail millet semolina, the ash content increased as the foxtail millet content increased.

4. Changes in protein content of dosa. The protein content of control sample was observed lowest when compared with the all the treatments. The moisture content of the samples consisting of rice flour i.e., T_1 and T_2 decreased. Similarly, the samples with no addition of rice flour i.e., T_3 and T_4 also decreased. The protein content was increased for the treatments, T_2 to T_3 because foxtail millet content was decreased. Among the treatments the high protein content observed for T_3 i.e. 15.5 % and the second lowest protein content was observed for T_2 i.e. 14.1 % (Fig. 6).

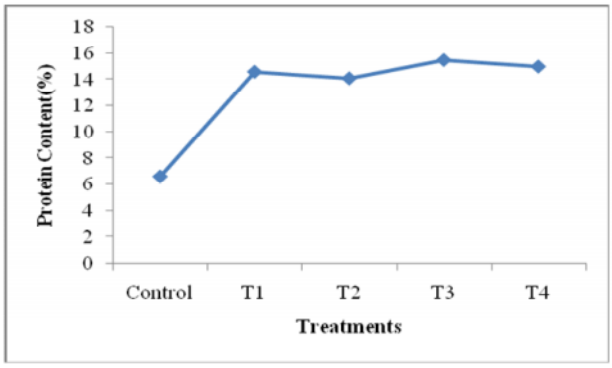

Fig. 6. Variation of protein content upon different treatments in dosa.

Protein content of control sample was observed lowest when compared with the other treatments because black gram and rice flour have low protein content than foxtail millet. The protein content of T_3 was high among the treatments as the ratio of black gram and foxtail millet were 2:1. Similar results were also recorded by Krishnamoorthy *et al*. (2013) for dosa prepared from Foxtail Millet dosa mixes. Anju and Sarita, (2010) revealed that products that are prepared from foxtail millet had more protein compared to wheat flour.

5. Changes in crude fibre content of dosa. The crude fibre content of different samples was analyzed and represented as shown in Fig. 7. The crude fibre content of control sample was observed to be low when compared with the other treatments. The crude fibre content increased for all the treatments except for the treatment, T_3. Among the treatments the highest crude fibre content was observed for T_4 i.e. 3.85 % and lowest crude fibre content was observed for control as i.e. 1.42 %. The crude fibre content of control was observed low when compared with the other treatments because black gram and rice flour have low crude fibre

content than foxtail millet. The crude fibre content was also low for treatment, T_1 as the foxtail millet content was low when compared to T_2.

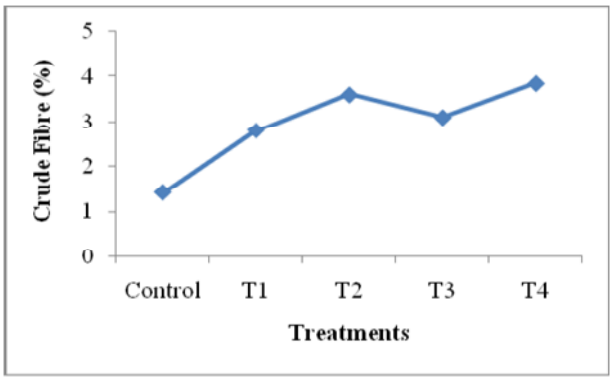

Fig. 7. Variation of crude fibre content upon different treatments in dosa.

The results obtained were in accordance with Krishnamoorthy *et al*. (2013) for Dosa prepared from Foxtail Millet Dosa mixes. Anju and Sarita, (2010) revealed that products that are prepared from foxtail millet had more crude fibre compared to wheat flour. Ketki *et al.* (2017) revealed the results in contray that the crude fibre content decreased with the increase in foxtail millet content.

II. Sensory Evaluation of Different Treatments of Dosa

It was evident that control sample dosa scored significantly higher than the dosa prepared by incorporation of foxtail millet in all attributes except texture. The texture was recorded high for T_1 foxtail millet Dosa whereas taste was same for control and treatment, T_1 (Fig. 8). The overall acceptability was recorded highest for the control sample i.e., 8.3. Among all the treatments, as the FM content increased the bitterness increased, so the taste was high for T_1 and control samples of 8.5.

Texture of Dosa prepared by using foxtail millet especially treatment, T_1 was of similar quality and most accepted as that of control Dosa, that is prepared from rice flour. The reason for the texture of both control and T_1 samples to be reasonably good, might be because of the similar swelling power of foxtail millet starch and rice starch. This might be reason for good mouth feel in terms of texture.

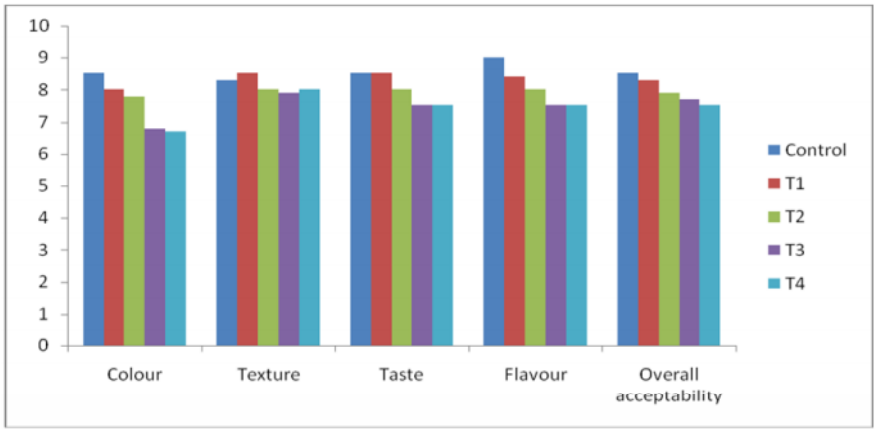

Fig. 8. Sensory evaluation of different treatments of dosa.

CONCLUSION

In the present study, the dosa breakfast mix was developed by incorporation of raw foxtail millet at different levels (25%, 35%, 40% and 50%). All the formulated mixes were used in the preparation of dosa, cooked and subjected to physicochemical and sensory analysis. The different physicochemical analysis included the moisture, fat, ash, crude fibre and protein contents. The samples were also subjected to sensory evaluation to untrained panel based on the nine point Hedonic scale. It can be concluded that the foxtail millet can be readily used for formulation of breakfast mixes. The moisture content of traditional Dosa was high when compared to millet based dosa about 1.08%. The ash and fat contents of millet based dosa were high when compared to traditional dosa about 2.5 % and 8.5 %, respectively. Sensory evaluation indicated that the 25g foxtail millet dosa had colour scores as 8. The texture, taste, flavours and overall acceptability was more for 25g followed by 50g foxtail millet dosa treatments. Consumption of these nutrition rich diet not only increases the immunity of humans but also increases the production of these millets. This could increase the sustainability in food security. The future work can be carried on different combinations of millets and levels of millets for increased nutrient availability to consumers.

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Conflict of Interest. The author has no conflicts with the subject matter or resources conferred in the current manuscript.

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