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Research Article

Turmeric Spent Flour: Value Addition to Breakfast Food

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Abstract

The study has focused on turmeric spent utilization for preparing of value added products. Dosa also an Indian pan fried product is a power packed healthy breakfast or snack and prepared by raw rice (Oryza Sativa) and black gram (Vignamungo L.). Turmeric Spent Flour (TSF) was added to the batter by replacing rice at 10, 25 and 50% on the weight basis. The batter was fermented at room temperature and was analyzed for its microbial and physicochemical properties. During the fermentation, the batter increased to twice its volume at 28±2 ºC. The initial pH of the batter was 6.1±0.3 and after 12hrs, it lowered to 4.9±0.6. The fermented batter showed, L*, a*, b* and ΔE values of 74.6 to 90.7, -4.2 to 2.8, 9.8 to 57.7 and 3.11 to 48.0, respectively. Sensory evaluation of TSF dosa (up to 25%) added was comparable in sensory characteristics with the control.

Keywords: Turmeric Spent Flour; Fermentation; Sensory Evaluation; RVA; Breakfast Food

Introduction

The ever expanding spice processing industries have to concentrate on the utilization of by products and waste generated during processing of spices by turning into value added products. Turmeric is an important tropical spice primarily valued for its color, aroma and antioxidant properties. It is an essential ingredient of several culinary curry powder formulations and extensively used in food, pharmaceutical and cosmetic industries. Turmeric has carbohydrate 63-65%, protein 5-6%, crude fiber 4.3% and mineral 2.7% [1]. World production of turmeric is estimated to be about 1.115million tons of which India alone accounts for ~80% [2]. It is estimated that about 200 tons of turmeric oleoresin are exported from India annually. In this process, nearly 140 tons of mother turmeric liquor, termed as Curcumin Removed Turmeric Oleoresin (CRTO), and 18000tons of spent are produced by the turmeric oleoresin industry and this spent does not have any commercial utility. Curcuminoids in turmeric powder contain curcumin, de methoxycurcumin and bisdemethoxycurcumin to the extent of 70-75, 20-18 and 10-7%, respectively [3]. Many reports are available on the pharmacological applications of turmeric like anti-inflammatory, anti-microbial, antioxidant, hypoglycemic, hypocholesterolemic anti-mutagenic and anti-cancer [4,5,6,7,8,9]. Leonel et al. (2003) have extracted starch from C. *zedoaria*, C. *longa* and C. *malabarica*; no significant differences were observed between these two species in respect of granule shape, size, and amylose content [10]. Braga et al. (2006) have observed that turmeric rhizomes contained about 40% (w/w) starch, isolated after the extraction of oil from turmeric by using supercritical fluid extraction [11]. Antimicrobial property of turmeric spent in streptozotocin-induced diabetic rats were reported by [12].

In recent years, spices and their spent are accepted as functional food and nutraceuticals since they provide dietary fiber, carbohydrates, energy, minerals, vitamins and antioxidants required for human well-being and good health [13]. Idli/Dosa is a popular traditional fermented food, prepared and consumed as a staple food throughout India, particularly in a southern part of India as well as in Sri Lanka [14,15]. It is prepared by the acid leavening steam cake made from rice and black gram dhal. They are easily digested and often recommended food for infants and patients [16]. Leuconostoc mesenteroides, Streptococcus faecalis and Pediococcus cerevisiae are the major microorganisms involved in the fermentation process [15]. They produce flavour, enzymes and help in saccharification of starch [17]. Recently, the effect of emulsifiers and ingredients such as oat bran, maize resistant starch and chickpea flour on rheological, nutritional and quality characteristics of the high protein, high fiber and low carbohydrate bread are reported [18,19]. Batters containing soybeans are highly nutritious followed by mung bean batters while the conventional black gram product is organoleptically most preferred [20]. The present work is aimed to provide more insight into the utilization of turmeric spent, and to improve the overall nutritional status of breakfast foods. Hence, the study reports about the partial replacement of rice with TSF in dosa to improve the nutritional quality regarding essential minerals and functional compounds such as curcuminoids.

Materials and Methods

Rice (Oryza sativam L.) and Blackgram (Phaseolus mungo L.) were procured from the local market of Mysore. Turmeric Spent Flour (TSF) was collected from a local Turmeric oleoresin industry. It was tested for residual solvent analysis by GC. All solvents/chemicals used were of AR/HPLC grade and obtained from E-Merck, Mumbai, India and Sigma-Aldrich Co., Missouri, USA.

Batter preparation

Dosa batter was prepared by using raw materials like raw rice, black gram and TSF in 10, 25 and 50% (on the weight basis). Ingredients, were soaked in water for 4hr and ground in a mixer grinder, separately allowed for fermentation at room temperature and was analysed for its Physico-chemical and microbial quality.

Following four treatments provides the ingredients of their respective proportions:

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1. Black gram 250 g + Rice 1 kg (Control)
2. Black gram 250 g + Rice875 g + TSF 125 g
3. Black gram 250 g + Rice 750 g + TSF 250 g
4. Black gram 250 g + Rice 500 g + TSF 500 g

Colour measurement

TSF added along with control was subjected to colour measurement using Hunter Colorimeter (Hunter Associates Laboratory, USA) [21]. The change in colour was measured and compared with the three colour coordinates namely, L*, a*, and b*. Where L* represents the lightness index, a* represents red-green, and b* represents yellow-blue colour components. The instrument was calibrated using a standard white i.e. (L*=90.70, a*=-1.08. b*=0.65 illuminate D65 and view angle 10°C). Chroma indicates the purity of the colour or hue as measured along an axis. Hue angle visualizes how an average person see's the colour.

Scanning electron microscopy (SEM)

The dehydrated batter powder was mounted on aluminum stubs rendered conductive by coating with gold employing a sputter coater (Polaron PS 3) and examined under SEM (Leo Electron Microscopy, Model 435 VP, Cambridge UK) at an accelerating voltage of 20 kV. After attaining vacuum of 0.1-0.2 Torr and plasma current of 42mA; gold coating was continued for 140s. The samples were examined at 2000X magnification, and a representative microphotograph was taken and presented for interpretation.

Proximate composition

Moisture (44-16), ash (08-01), fat (30-26), crude protein (N × 6.25) (46-10), sugars (80-60) and starch (76-11) contents in TSF were determined by AOAC (2000) standard method [22].

Minerals

Mineral contents of dosa batter powder and also TSF were determined (AOAC 2000) by Atomic Absorption Spectrometry (AAS) [22]. Starch (5g) was converted to ash and dissolved in 2mL of concentrated nitric acid. The volume was made up to 25mL using double distilled water. The calibration curves were prepared from standards. The sample solution was aspirated and the concentration was determined.

Bacterial load by spread plate method

Representative 10g portions of batter sample were aseptically weighed and homogenized with 90ml sterile physiological saline (0.85% w/v sodium chloride, pH 7.2). Serial decimal dilutions were prepared with the same diluent and duplicate counting plates were prepared using appropriate dilutions. For surface seeding, 0.1ml of the dilution was spread on the surface of dried plates. After incubation at 35±2°C colonies that appeared on the selected plates were counted as colony forming units (cfu) per gram fresh weight sample. The standard plate count for total aerobic mesophilic bacteria was carried out in spread plates of plate count agar (PCA; HiMedia M091), HiMedia Laboratories, Mumbai 400086, India incubated at 35±2°C for 18-24 hr [23].

Pasting characteristics of batter

The pasting characteristics of batter were determined using micro visco-amylograph (Brabender GmbH & Co., Kulturstr, Germany). By heating 5% batter slurry from 30°C to 92°C at the rate of 7.5°C/min and held at 92°C for 5min and then cooled to 50°C at the same rate and held for 1min at 50°C. Measuring range used was 120 (cmg) at a speed of 250rpm as per the standard protocol. Peak viscosity, hot paste viscosity, cold paste viscosity and gelatinization temperatures were determined.

Table 1: Turmeric spent flour composition.

Parameters	Concentration (%)
Moisture	5.20±0.05
Fat	0.06±0.01
Protein	5.90±0.07
Starch	52.00±0.77
Reducing sugar	11.07±0.04
Ash	7.60±0.04
Curcumin	0.005±0.2

Values are mean ±Standard deviation.

Table 2: Mineral contents in turmeric spent and turmeric incorporated batter.

Minerals (mg/100 g)	Turmeric spent (mg/100g)	Control	Batter with TSF		
			10%	25%	50%
Cu	5.5±0.02	4.3±0.04	3.9±0.12	4.4±0.02	5.2±0.06
Fe	91.3±0.18	17±0.09	40±0.07	49±0.26	63±0.25
Mn	25.8±0.07	5.1±0.04	8.1±0.05	11±0.06	15±0.10
Mg	15.1±0.05	5.7±0.04	8.9±0.05	11±0.05	13±0.04
Zn	5.6±0.03	5.4±0.02	7.6±0.06	5.8±0.04	9.9±0.11

Values are expressed as Mean±Standard deviation.

Dosa preparation

Sodiumchloride (NaCl) was added to the batter at 2% wt/total wt of raw material, and the batter was allowed to ferment for 12hr naturally. No effort was made to control the temperature during fermentation (the aim was to study the physical characteristics of the dosa fermentation as done traditionally); tche temperature varied between 20°C to 26°C [24].

After fermentation, batter (1/4 cup) pours in the centre of griddle from the help of a ladle. Using bottom of the ladle, quickly spread batter outward in a circular motion to a diameter of about 7inches. Drizzle 1/2 teaspoon oil over the top. Leave dosa batter to brown gradually until outer edges begin to look dry, (about 2minutes) cooking on one side only. Later sensory analysis of these samples was carried out by a trained panel in sensory booths.

Sensory analysis

Sensory analysis of samples was carried out by a trained panel using individual sensory booth rooms. Evaluations were conducted under the white fluorescent light, with the booth area maintained at temperature 22±2°C and RH 50±5%. Descriptors were generated by the general agreement of panelists. Samples were presented in porcelain plates coded with 3 digit random numbers. The panelists were recruited and trained as per the standard [25]. A 15 member pool panelists were selected and 7 subjected were participated regularly in the analysis. A glass of water was also presented to cleanse the palate in between the samples. The DQA data were analysed

Table 3: Instrumental color parameters for fermented batter.

Samples		L*	A*	B*	ΔE*Ab
Before Fermentation	Control	88.56±0.68f	-0.44±0.20a	11.96±0.25b	------
	TSF 10%	81.51±0.58d	-0.73±0.14b	42.73±0.17c	31.57±0.20
	TSF 25%	78.09±0.26c	1.51±0.11d	52.38±0.12f	41.80±0.20
	TSF 50%	71.10±1.49a	6.49±0.10h	60.11±0.10h	51.68±0.13
After Fermentation	Control	90.75±0.63g	-0.94±0.03c	09.81±0.06a	3.10±0.02
	TSF 10%	86.07±0.19e	-4.22±0.11g	43.54±0.11d	31.90±0.76
	TSF 25%	81.51±0.10d	-2.00±0.10e	50.98±0.26e	39.6±0.19
	TSF 50%	74.61±0.39b	2.87±0.10f	57.77±0.12g	48.00±0.41

TSF-Turmeric spent flour.
Mean scores with different letters differ significant at p<0.05 by LSD.

for their significance by LSD at p<0.05. Quantitative Descriptive Analysis (QDA) having 15cm unstructured scale was used for the sensory analysis. Panelists were asked to mark on a scale of 0-15 cm to indicate the intensity of each attribute listed on the score card [26]. The scale was anchored at 1.25cm on either end, representing 'Recognition Threshold' and 'Saturation Threshold' respectively. The scores given for all the attributes for each sample were tabulated and the mean scores were calculated using Excel spreadsheets. The sensory profilogram were generated based on the group means over sensory attributes.

Results and Discussion

Composition of Turmeric Spent Flour (TSF)

The data on the proximate composition of TSF, presented in (Table 1) shows that the flour had 5.2±0.05% moisture, 7.6±0.04% ash, 5.9±0.07 protein, reducing sugar 11.07±0.04 (%), Curcumin (0.005%) and 0.06±0.01% fat. The starch is the major constituent (52±0.77%) in TSF.

Mineral composition of TSF (Table 2) shows a higher content of iron, followed by manganese, zinc, copper and magnesium. Hence, TSF is rich with starch and essential minerals. Dosa batter blend was prepared by substituting TSF flour at 0, 10, 25 and 50% levels. The mineral content of dosa blends with TSF shows (Table 2) that iron, manganese, zinc, copper and magnesium contents are increasing with increase in the level of TSF. Shalini and Sudesh (2005) found that addition of raw, soaked and germinated fenugreek flour to wheat flour increased the protein, lysine and dietary fiber content of the biscuits [27,28]. Thus, by indicating it's potential to replace other cereal/legume starches in food applications. Use of TSF not only replaces starch but also incorporates curcuminoids that can act as a functional ingredient.

Colour is an important criterion for food acceptability, especially in daily food preparations. Results in Table 3 shows that, L*, a*, and b* of batter are 88.56±0.68, -0.44±0.20, 11.96±0.25, respectively. The addition of TSF decreased L* values and increased b* values in the batter. The L* values decreased from 90.7 to 74.6, and the b* values increased from 9.8 to 57.7 when the TSF content was increased from 0 to 50% in the batter. The colour effect of TSF on dosa may be mainly due to the presence of curcuminoids. The initial pH of the batter was 6.1±0.3 and after 12hr of fermentation it decreased to 4.9±0.6.

Dosa made with rice, and black gram (1:1) batter volume increased about 47%, the pH fell to 4.5, and total acidity rose to 2.8% (as lactic acid) during 12-15 hr of fermentation at 30°C [29]. The essential physical change in the batter is that it becomes leavened by CO_2 gas along with the development of pleasant flavor. In the present study, dosa batter was prepared by grinding wet ingredients such as raw rice, black gram to serve as a control. TSF was added to the dosa batter at 10, 25 and 50% on a weight basis by replacing rice. After 12hr fermentation, the batter volume increased to almost twice its initial volume at 28±2°C. Results (Table 4) showed that addition of TSF did not significantly affect the microbial load. Purushothaman et al. (1977) reported that the major microorganisms involved in the fermentation process are Leuconostoc mesentroides, Streptococcus faecalis, Torulopsis candida and Trichosporon pullulans [25].

Table 4: Bacterial enumeration of dosa batter.

Samples	Before Fermentation (Cfu/G)	After Fermentation (Cfu/G)
Control	5.6±0.075a	6.8±0.82b
TSF 10 %	6.1±0.051a	7.0±0.014b
TSF 25 %	5.7±0.149a	7.2±0.062b
TSF 50 %	5.3±0.022a	6.5±0.042b

Mean scores in a row with different letters differ significant at p<0.05 by LSD.

Sensory studies showed that TSF added dosa is comparable to the control. Sensory characteristics of TSF added dosa indicated that TSF has a potential for application in different food products. Sekar and Mariappan (2007) reported that in dosa preparation, wheat, bajra (Pennisetum typhoideum Rich.), maize or kodri instead of rice and sprouted peas, cowpea (Vigna catjang walp.), field beans (Dolichos lab, lab L.), soybeans or fresh groundnut oil cake instead of black gram could be used. Spent turmeric flour feeding at 10% level controlled the diabetic in rats to the extent of 18%. The effect may be mainly due to the presence of curcumin [9,28].

Pasting profile

Pasting characteristics were profiled by using a Rapid-Visco-Analyser (RVA). Incorporation of TSF in dosa batter exhibited lower pasting profile. Fermented dosa batter Figure 1B showed lower pasting profile than unfermented Figure 1A dosa batter. The pasting characteristics of batters are shown in Figure 1. Batter with TSF showed a relatively high gelatinization temperature (74.8°C) compared to control (68.28°C) and steep increase in viscosity once the initial peak was reached. This confirms the presence of homogeneous bonding force and peak viscosity of 498BU was reached in 4.30min.

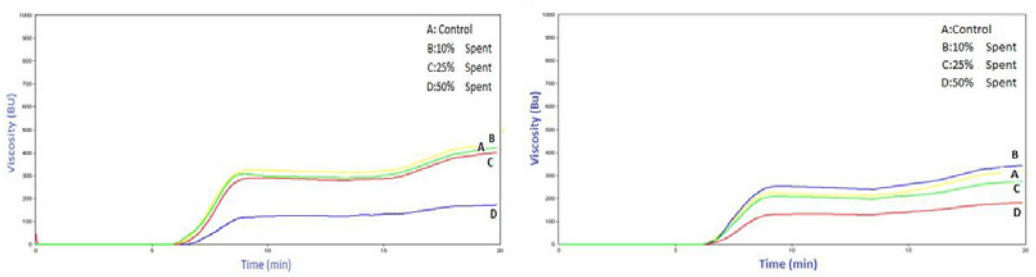

Figure 1: Pasting profile of micro visco-amylograph of fermented and unfermented dosa batter.

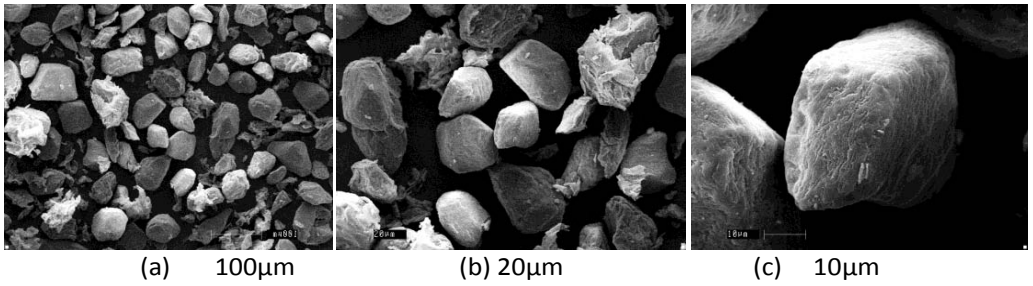

Figure 2: Turmeric spent flour image by using Scanning Electron Microscope (SEM).

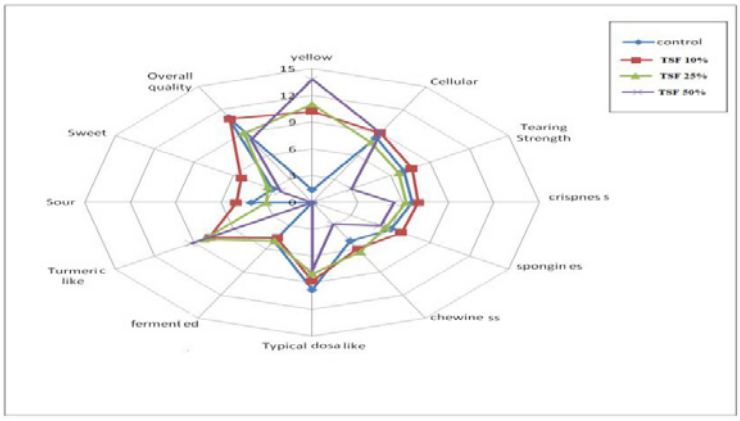

Figure 3: Sensory profile of fermented batter with turmeric spent.

On holding at 92°C, the viscosity reduced to 455BU and on cooling to 50°C retrograded to a final viscosity of 669BU. Batter with TSF showed high breakdown viscosity indicating poor stability. The low setback of the batter indicates its potential application, particularly in breakfast foods. Similar reports were made by Madhava Naidu et al. (2011) ginger spent flour agonised more viscosity breakdown (115BU) indicating its poor capacity to withstand severe processing conditions [30]. Viscoamylography indicated the pasting (gelatinization) temperature to be 81°C and 78°C for C. longa and C. *zedoaria* starch, respectively [31].

Scanning Electron Microscope (SEM)

The scanning electron micrograph of TSF is shown in Figure 2. The shape of the granules is round, flat, almost uniform in size and having a smooth surface. The average granule size is 22.5 ± 3.5µ in length and 16.9 ± 4.8µ in width and thickness is about 3µ. The granules of TSF can be classified as small to medium according to the classification of [32]. Jyothi et al. (2003) reported the particle shape and sizes were an elliptical or triangular shape with an average granule size of about 35µm for C. *zedoaria* [33].

Sensory analysis

The results of the sensory analysis showed that sample 4 (TSF 50%) had high yellow color followed by samples 3 and 2 (TSF 25 and 10%) which had the same intensity of color, whereas control dosa sample was almost white colored. Tearing strength and chewiness were more for sample 4. As seen in Figure 3 all the four samples are acceptable. However, control and sample 2 had the high score for overall quality (11.1). Recently, Joachim (2012) worked on the evaluation of pan bread supplemented with gluten, lupin, fenugreek and turmeric flour blends and recommended to utilize whole meal flour, fenugreek, lupin and turmeric flour, to prepare healthy diets to deal with diabetic status and control of some biological parameters [34].

Conclusion

Sensory studies of dosa prepared with added TSF (10-25%) was comparable to the control dosa thereby indicating that, TSF has the potential to replace cereal/legume starches for food applications. TSF also incorporates curcuminoids that act as nutraceuticals. Dosa batter with TSF showed high breakdown viscosity indicating its deprived stability under severe processing conditions. The low setback of the batter is the indication for its potential application in breakfast foods.

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