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Functional Quality Analysis of Composite Flour from Millet and Xanthan Gum for Pasta Dough

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ABSTRACT

Background: The main aim of this study was to determine the functional and physical characteristics of composite flour prepare with flour of rice, finger millet and xanthan gum which can be with rice flour, finger millet and xanthan gum flour which can be used in the manufacture of pasta and bread in India due to its easy availability.

Methods: Xanthan gum at 0, 0.5, 1.0, 1.5 and 2.0% level were mixed in uniform amounts of flour prepared with finger millet and rice flour. The functional and physico-chemical parameters like ash, moisture, protein, fat and other properties like swelling power, water retantion capacity, foaming capacity, bulk density and oil absorption capacity were determined.

Result: Moisture, ash, fat and protein were 9.8-10.6%, 1.1-3.8%, 1.9-1.8% and 7.4-7.1%, each. The composite flour moisture content was under 12%, making safe storage for a long time. The water retention capacity, swelling power, bulk density, oil absorption capacity and foaming capacity as determined were 7.02 to 7.35 g/g, 106 to 364%, 0.869 to 0.994 gm/ml, 4.0 to 2.9% and 85 to 127%.

Key words: Finger millet, Functional properties, Physical properties, Rice, Xanthan gum.

INTRODUCTION

Millets play an important role in reducing malnutrition all over the world including India. Millets contain a good amount of calcium, iron and carbohydrates apart from other nutrients. Different cereal flours and millets differ from one another in terms of their biochemical composition, molecular structure, conformation of nutritional components and functional properties (Alleoni, 2006). Finger millet, often known as ragi, is commonly used by many people. In some parts of India and South Africa, finger millet is a major ingredient in their balanced diet. Free from gluten and having less amount of sugar with lots of nutrition and good source of micronutrient they are left aside.

Rice is the next most widely consumed cereal grain worldwide. In many cultures, rice is served as the main dish. Rice is a good source of carbohydrate preferred by people globally. Rice is composed of approximately 2.2% fat, 7.37% protein, 0.8% fibre, 64.3% accessible carbohydrates and 1.4% ash.

Xanthan gum plays an important role in thickening emulsifying and stabilizing water-based foods. To regulate the viscosity of the liquid marinade xanthan gum is used widely in food processing. At low pH values and high temperatures, xanthan is a good hydrocolloid for steady aqueous dispersions, suspensions and emulsions. The cohesiveness of its solution does not have a role but thickening after unrepeatable makes it irreplaceable for stabilizing and thickening. Production process of xanthan gum involve fermenting xanthomonas bacteria culture in a medium that contain sucrose, glucose, starch, *etc*. like substrate and other useful nutrients to facilitate growth. This is completed through batch fermentation process under optimal conditions. Xanthan gum is used for lowering total cholesterol and blood sugar in people with diabetes. It is also used as a laxative. Xanthan gum is also used as a saliva substitute in people with dry mouth (sjogren's syndrome).

Physical and chemical properties are indeed the main properties that include a complex teamwork between the content, structure and molecular arrangement of food part and the nature of the environment with which they are linked and quantified. Functional characteristics of flour helps in predict how fat, protein, carbohydrates and fibre will work in a certain way and accompany whether or not this protein may be used to change or improve structured protein (Kaur and Singh, 2006).

The aim of this analysis was to prepare composite flour from rice, finger millet and xanthan gum, to inspect the physical and functional features of the composite flour that can be use for a variety of utilisation.

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MATERIALS AND METHODS

Rice flour brand (*Manna*), finger millet flour brand (*Manna*) and xanthan gum flour brand (*Nature vit*) flour were purchased from the nearest market. Rice, finger millet and guar gum flour were sifted with 100 micron sieve. Whole flour samples were packed in poly bags and stored in normal temperature for other examination. Research works were performed in Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj, U.P, India.

Composite flour and Dough proportion

Different proportion of rice, finger millet and xanthan gum flour were taken for making dough, as shown in Table 1. The five mixtures were considered based on extruder's smooth moldability and on preliminary trial.

Moisture content (%)

Moisture content was analysed as per AOAC method by using oven. Sample was taken in Petri dishes at the temperature of 100°C-105°C and placed inside the oven for 4 hours. Dish was kept inside dessicator for cooling. The final weight of petri dishes was taken and calculated by Equation 1.

$$\text{Moisture (\%)} = \frac{(W_2\text{-}W_3)}{(W_2\text{-}W_1)} \times 100 \quad \text{...(Eq 1)}$$

Where:
W_1= Dish mass
W_2= Dish mass and sample before drying
W_3= Dish mass and sample after drying

Ash content

Ash content was determined as per (AOAC, 2005) method. Sample of ash was weighed with crucible dishes at a weight range from 3 to 5 g. The sample was heated in a muffle furnace at 550°C temperature for five hours. After that being allowed for cooling, samples were then weighed and percentage of ash was calculated.

Fat content

The fat content was calculated with sample's fat loss weight (AOAC, 2002). Semi-continuous solvents extraction process was completed by soxhlet method. In this method, samples were totally soaked for 5 to 10 minutes in a solvent before being taken in distillation unit. After that solvent was completely used, it's evaporated, weighed and dried. The extraction method took about four hours, at 70°C. After solvent was complete taken out and it was evaporated, weighed and dried.

Protein content

Protein content was estimated by using the AOAC (2005). Food materials were thoroughly broken with strong acid and nitrogen was produced during this process, which was estimated by the titration method, in this procedure. The protein content was determined based on the nitrogen concentration of the food (Maehre *et al.,* 2018).

Swelling capacity

Swelling capacity of composite flour was determined by (Chandra and Samsher, 2013). The approached outline was used to optimize swelling capacity. Theprocedure used was taking a 100 ml graduate cylinder was made up to the 10 ml marking with a sample of flour. 50 cc of distilled water was used to make up the volume of flask. The solution was mixed by tightly covering the top of measuring cylinder. After waiting for 2 minutes sample was upside down and permitted to wait for an additional 8 minutes before whole volume was evaluated. Swelling capacity was calculated using Equation 2.

$$\text{SC(\%)} = \frac{\text{Wrw}}{\text{Ws}} \times 100 \quad \text{...(Eq 2)}$$

Where:
Wrw= Sample weight along with retained water.
Ws= Sample weight.

Water absorption capacity (WAC)

The water absorbing capacity of sample was calculated in conferring with Sosulski and Slinkard, (1976). One gram of flour was mixed in ten millilitres of distilled water and kept at normal temperature for approx 30 minute. The solution was then centrifuge for 3000 rpm for 30 min. The evolved liquids were poured and removed for extra moisture. Centrifugation tubes were weighed once more and WAC was calculated by Equation 3.

$$\text{WAC (\%)} = \frac{(W_2\text{-}W_1)}{W_0} \times 100 \quad \text{...(Eq 3)}$$

Where:
W_2= Weight of the tube and sediments.
W_1 and W_0= Weight of tube and weight of sample.

Bulk density (BD)

Bulk density was obtained by Jones *et al.* (2000). A calculated weight of flour was transferred in a weighted (W_1) analysis cylinder and both cylinder's weight (W_2) and the flour's volume (V_1) were noted. Bulk density was analysed as the difference of flour weight to analysing cylinder volume by using this formula Equation 4.

$$\text{BD (g/ml)} = \frac{(W_2\text{-}W_1)}{V_1} \times 100 \quad \text{...(Eq 4)}$$

Foaming capacity (FC)

The foaming capacity was calculated by the Narayana and Narsinga, (1982). 1 g of sample was mixed with 50 ml of distilled water at 30°C in measuring cylinder. This mixture was properly mix and shaked for 5 min to produce foam. Using Eq 5, volume of the foam 30 seconds after frothing was represented as foam capacity:

$$\text{FC (\%)} = \frac{\text{Volume of foam AW-Volume of foam BW}}{\text{Volume of foam BW}} \times 100 \quad \text{...(Eq 5)}$$

Where:
AW= After whipping
BW= Before whipping

Oil absorption capacity (OAC)

Oil absorption capacity was determined by Sosulski *et al.,* (1976). One gram of flour was mixed in ten millilitres of vegetable oil and left to stand at normal temperature. Mixture was centrifuged at 2500 rpm for 30 minutes. Oil absorption capacity was calculated as amount of oil bind per g of flour by using Equation 6.

$$OAC\ (\%) = \frac{(W_2 - W_1)}{W_0} \times 100 \quad \text{...(Eq 6)}$$

Where:
W_2= Weight of the tube and sediments
W_1 and W_0= Weight of tube and sample weight

Statistical analysis

All treatments were replicated three times. Significant difference was analysed using one-way ANOVA. Analysis of variances was access to find out statistically significant changes in functional and physical attributes of mixed flour samples.

RESULTS AND DISCUSSION

Proximate analysis

Moisture content of the composite flour from T0 to T4 is shown in observation Table 2 that ranged from 9.8 to 10.6% as differentiated to propose result of 11 to 15% depends upon stored condition and water absorption type of flour. The moisture percentage was seen to be non-significantly different ($p>0.05$) among mixture. T0 had the lowest moisture content that is 9.8% and highest moisture percentage was calculated in T4 that is 10.6%. FSSAI, (2022) recommended below 12% is the moisture level for storage and the moisture content for the composite flour less than 12. To prevent microbial action and chemical changes moisture absorbing capacity should be below 14% (Shahzadi *et al.,* 2005). It was also supported by Liu *et al.* (2012); Butt *et al.* (2007) and Karaman *et al.* (2014) for noodles, chapaties and flour respectively. ANOVA result for moisture content of composite flour showed that the different ratio of flour for moisture content is non-significant ($p>0.05$). On basis of single factor ANOVA, the moisture content of composite flour was calculated and found non-significant at 5% level of significance.

In organic residue referred as ash in food that is still present after organic material has been burned. It serves as a general indicator of flour yield and is typically related with the proportion of bran (Butt *et al.,* 2007). In organic residues of composite flour for T0 to T4 valued from 1.11 to 3.82%. As observed in Table 2 the lowest ash value was found in T0 composite flour is 1.11% and highest ash value was analysed in T4 composite flour that is 3.82%. In T0, Xanthan gum flour level was lower than in T4. T0 composite flour does not have a binder. Ash content is directly proportional to the level of xanthan gum flour is directly proportional to inorganic substances. The amount of ash in the blended sample increased with direct increase of rice and ragi flour (Twinomuhwezi *et al*., 2020). Similar results were obtained by Butt *et al.* (2007); Awolu *et al.* (2015) and Iqbal, (2000) for chapaties, pasta and bread respectively and for ash value at other amount of guar gum and xanthan gum contained composite flour. T0 (ragi and rice) flour had a lowest ash level (1.75%) due to the lack of xanthan gum enrichment. Ash content in composite flour does not correctly show the materials in mineral matters in original food there may be some losses (Twinomuhwezi *et al*., 2020). Means for ash content indicated that ash content effects in various composite flour samples were significant ($p<0.05$) (Anjum *et al.,* 2002). On calculating the data using single factor ANOVA, the ash content in composite flour was found at 5% level of significance.

Fat content of composite flour samples was observed to be in the range from 1.95 to 1.85% for T0 to T4 xanthan gum incorporated as shown in Table 2. Composite flour solution T0 sample was without xanthan gum binder and T4 mixed flour sample seen to be 2.0% xanthan gum flour. Maximum fat content was examined in T0 composite flour sample that was 1.95% and lowest fat content was examined in T4 composite flour sample that was 1.85%. These values are very similar to Twinomuhwezi *et al.* (2020); Awuchi, (2019), Kulkarni *et al.* (2012) and Gunasekara *et al.* (2021) for pasta, noodles and muffins respectively. Fat content of xanthum gum is very high (1.77%). T4 has high amount of fat contents compared to T0. Products durability depends on the unsaturated fatty acids as they are more vulnerable to oxidative foulness, if it exceeds the calculated level food

Table 1: Formulation chart.

Samples	Rice and Ragi (Flour %)	Xanthan gum flour (%)
T0	50:50	0
T1	47.5:47.5	0.5
T2	45:45	1.0
T3	42.5:42.5	1.5
T4	40:40	2.0

Table 2: Proximate analysis of composite flour.

Sl	Moisture (%)	Ash (%)	Fat (%)	Protein (%)
T0	9.8±0.30	1.11±0.008	1.95±0.03	7.49±0.01
T1	10.2±0.17	2.96±0.05	1.94±0.01	7.47±0.03
T2	10.3±0.16	3.20±0.05	1.92±0.02	7.41±0.01
T3	10.5±0.15	3.45±0.04	1.89±0.05	7.31±0.02
T4	10.6±0.14	3.82±0.04	1.85±0.01	7.18±0.02

becomes delicious by high-fat flours as it intensifies the flavour of food as stated by Tenagashaw *et al.* (2015). Fat content does not play any significant role in pasta (p>0.05). On basis of single factor ANOVA, the fat content in composite flour was found non-significant at 5% level of significance. Sample T4 has the highest xanthum gum as compared to T0. According to Kulkarni *et al.* (2012) addition of xanthan gum flour in composite flour in dry form had direct affect on protein content. So T4 composite flour sample have lower protein content as compared to T0 without xanthan gum. This finding proves the observation of Kulkarni *et al.* (2012) and Hymavathi *et al.,* (2019) for pasta and noodles. Means for protein content indicated that protein content effects in various pasta samples were non-significant (p>0.05). On basis of single factor ANOVA, the protein content in composite flour was found non-significant at 5% level of significance.

As shown in Table 3 the swelling capacity (SC) in mixed flour ranged from 7.02 to 7.35 g/g for T0 to T4 xanthan gum incorporated composite flour. T4 composite flour had 2% xanthan gum flour while T0 been without xanthum gum. Highest swelling capacity was observed in T4 composite flour that is 7.35 g/g. Gong *et al.* (2021) reported that swelling capacity is directly proportional to increased in amount of xanthan gum. Similar analysis was reported by Gong *et al.,* (2021); Falade and Okafor, (2015) for oat roll and composite flour respectively. Swelling capacity depends on the protein and starch content. Starch may be set within a protein matrix with highly stiff position, when the protein content is high which subsequently limits the access of the starch to water and cause the swelling capacity (Aprinita *et al.,* 2009). Xanthan gum has a larger solution density than xanthan gum and gum solution density increased as solution concentration increased. The amount of dense stacking of molecules in the gum is measured by its density. Amount of xanthan gum in composite flour is directly proptional to value of swelling capacity are as Xanthan gum has high water holding capacity. This suggests that any chemical that is present in the gum has the capacity to release once it has converted into a gelatinous substance. Because xanthan gum hydroscopic capacity adding graded quantities of xanthan gum increases the gum solution's potential to swell. This increases xanthan gum binding capacity making it more useful in the food industry. Similar results were observed by Ezera *et al.* (2018) and Awolu, (2017) for gum based composite flour and millet based composite flour respectively. Swelling capacity of composite flour samples was found to statistically significant (p>0.05). On analysing data using single factor ANOVA, the swelling capacity of composite flour was found significant at 5% level of significance.

Water absorption capacity (WAC) is main factor at a time of processing and has suggestion for gumminess. WAC is also plays main role for consistency and bulking of product. As shown in Table 3, WAC for xanthan in gum mixed composite flour ranged from 106 to 364% for T0 to T4. Highest water absorption capacity was noted for T4 composite flour (364%) and lowest for T0 composite flour (106%). Therefore, it obtained that increased in amount of xanthan gum is proptional to WAC of flour. This result could be due to structural changes in flour, embody of xanthan flour which allows maximum water absorbing due to hydrogen bonding (Ognean *et al.,* 2016). High WAC is beneficial for product constancy and bulking and it helps to maintain the freshness of food products. Water absorption capacity increased during gelatinization due to hydrophilic nature of xanthan gum. It should be focused that WHC of gums is directly proptional to protein fraction present in the gums and the functional group of the polysaccharide fractions, which are water repellent groups. Additionally, certain functional groups that can bind water molecules may be present in gums (Amid *et al.,* 2013). Dogan *et al.* (2011) reported that xanthan gum have water repellent nature, so T8 composite flour have high (364%) water absorption capacity and T0 have low (106%) water absorption capacity. This similar examination was made in research study by Akinola *et al.* (2017); Tharise *et al.* (2014) and Awolu, (2017) for millet based composite flour respectively. Water absorption capacity of composite flour samples was found to be statistically significant (p>0.05). On analysing the data using single factor ANOVA, the water absorption capacity of composite flour was found significant at 5% level of significance.

As shown in Table 3, result of analysis also showed that bulk density of flour ranged from 0.869 to 0.994 g/ml respectively for T0 to T4. Composite flour T0 showing the lowest bulk density (0.869 g/ml) and T4 is expressed the maximum bulk density (0.994 g/ml). It has been found that high bulk density is a beneficial characteristic for packaging of food material of maximum nutrient content (Hassan *et al.,* 2013). Low density has been discovered to be advantageous in formulation of corresponding foods. Initial moisture content and particle size of composite flour are responsible for changes in bulk density. Incorporation of finger millet and rice increases the bulk density of composite flour. T0 have lowest (0.869 g/ml) and T4 have highest bilk density (0.994 g/ml). The results agree with findings of Akinola *et al.* (2017); Wolu, (2017), Eltayeb *et al.* (2011) and Chandra *et al.* (2015) for composite flour respectively. Bulk density of composite flour samples was found to be

Table 3: Functional characteristics of composite flour.

SI	SC (g/g)	WAC (%)	BD (g/ml)	FC (%)	OAC (%)
T0	7.02±0.11	106±0.81	0.869±0.01	4.0±0.8	85.0±0.4
T1	7.24±0.05	116±0.47	0.971±0.07	3.8±0.5	87.5±0.4
T2	7.26±0.05	161±0.44	0.974±0.06	3.6±0.4	101±1.2
T3	7.30±0.05	362±0.42	0.980±0.06	3.2±0.4	113±0.4
T4	7.35±0.06	364±0.40	0.994±0.05	2.9±0.4	127±0.4

statistically significant ($p>0.05$). On analysing data using single factor ANOVA, the bulk density of composite flour was found significant at 5% level of significance.

The foaming capacity (FC) ranged from 4.0 to 2.9% with T0 to T4 composite flour. As shown in Table 3 T4 flour having the less value 2.9%. Product formability is similar to rate of decreases of surface force of air/water combine cause by incorporation of protein molecule. Foaming capacity showed the level of adsorb air on the liquid air interface during bubbling or whipping and by ability to its create a cohesive viscoelastic layer by way of intermolecular attraction (Zhou *et al.,* 2011). This finding agrees with the observation of Falade and Okafor (2015); Elmoneim *et al.,* (2007); Chandra *et al.* (2015) for composite flour and bread respectively. Foaming capacity of composite flour data show statistically significant. On analysing the data using single factor ANOVA, the foaming capacity of composite flour was found significant at 5% level of significance.

Table 3 shown the oil absorption capacity [OAC] of mixed flour in different treatments. The Oil absorption capacity is important since oil acts as a flavour deposit and increased the improvement of palatability, mouth feel of foods and extension of shelf life (Aremu *et al.,* 2007). OAC of mixed flour ranged from 85% for T0 to 127% for T4 composite flour. The maximum OAC for mixed flour was access in T4 (127%) and minimum OAC for mixed flour was access in T0 (85%). Similar result was obtained by Sarkar *et al.* (2018) for composite flour. Protein, which is made up of both hydrophilic and hydrophobic components, is the main chemical factor affecting OAC. Oil absorption capacity of flour increased due to interaction of Xanthan gum molecules with oil molecules. When increase the concentration of xanthan gum, increase the intermolecular interaction (Zhang *et al.,* 2005). With lipid hydrocarbon chains, non-polar side chains of amino acids can generate hydrophobic interactions (Jitngarmkusol *et al.,* 2008). This finding agrees with the observation of Tharise *et al.* (2014); Zhou *et al.* (2011); Chandra *et al.* (2015) for composite flour and biscuits respectively. Statistical data showed significant for Oil absorption capacity. On analysing the data using single factor ANOVA, the oil absorption capacity of composite flour was found significant at 5% level of significance.

CONCLUSION

Functional characteristics of mixed composite flour were analysed by the proportion of rice, ragi and xanthan flour. Blends of rice flour, finger millet flour and xanthan gum flour had a dramatic influence on all functional properties. The maximum level of xanthan flour increased the water absorption capacity, oil absorption capacity, foaming capacity and decreased the swelling capacity and bulk density. Mixed composite flour may be utilized by food industries for the manufacturing of the different confectionary, bakery, breakfast, cereal products etc for maximum peoples including those in urban areas suffering from different types of health ailment.

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Conflict of interest

All authors declare that they have no conflicts of interest.

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