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RHEOLOGICAL PROPERTIES OF RIGATONI PASTA DOUGH FROM BLENDED FLOUR OF AMARANTH, RICE AND RAW BANANA POWDER

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Abstract– The rheological characteristics of rigatoni pasta dough made with various ratios of flour from rice, amaranth and raw banana powder were examined. Rheological characteristics such as water absorption, proving time, development time, extensibility, and tolerance index were determined using the Farinograph and Extensograph. Barbender, a German company based in Duisburg, was used to determine these values. Amaranth and rice flour's properties remained stable whereas those of raw banana flour changed by 2%, 4%, 6%, and 8%. Water absorption (500 B.U.) values ranged from 76.7% to 80.9%, and water absorption (14.0%) values ranged from 74.4% to 78.4%. For samples T1, T2, T3, and T4, the development times for the flour blend formulations were 0.6 min, 0.8 min, 0.7 min and 0.9 min, respectively. With the addition of banana flour, the tolerance index improved from sample T1 to T4, i.e. from 172 BU to 272 BU. Extensograph readings were recorded at curves that represented proving times of 30, 60 and 90 minutes. With an increase in proving time, the energy area decreased and extension resistance increased. All the samples ratio values were between the ranges of 0.5 and 03. The outcomes clearly demonstrated that the use of raw banana flour increased the rheological characteristics and the quality of the composite flour dough. Due to its high nutritional value and favourable effects on human health, this dough may be used to make pasta and other similar items.

INTRODUCTION

By itself, pasta is a nutritious food with good potential to serve as an excellent functional food when supplemented with other healthy foods. Of course, pasta is known to be a distinctive component of a classic healthy diet anywhere in the globe. Even more interesting is the extrusion cooking of amaranth in combination with nutritionally superior cereal grains like rice since it may be utilised to create nutritionally foods in the widely favoured form of a puffed extrudate (Krishnan and Prabhasankar (2012).

The grains of amaranth may be popped like popcorn or turned into flour. Due to its high protein content, which is between 16 to 18%, the international community has been more interested in it (Ronoh *et al.*, 2009), and its relatively well established essential amino acid patterns predict its high protein quality (Mugalavai, 2013). Amaranth protein includes substantial levels of iron, calcium, B vitamins, vitamin A, E, and C. (Mburu *et al.,* 2012) developed a supplemental food based on Kenyan Amaranth grain, which contained good concentrations of tocopherol, which is essential for baby growth and development; thiamine, riboflavin, and pyridoxine. Amaranth protein is rich in lysine (exogenous amino acids), contains considerable amounts of iron. Amaranth grain's environmental adaptability and nutritional content are qualities that may be utilized to attract consumers and encourage the consumption of the grain in Nigeria, particularly by the most vulnerable populations (women and children), in order to maintain nutrition security.

Rice is an important grain, and in the nations where it is produced, the majority of it is eaten as a milled kernel. Many broken kernels are sold at a

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discounted price to whole kernels during the milling process. While the price of whole rice kernels is significantly greater than that of wheat, maize, or oats, the price of rice flour derived from broken rice is reasonable. Rice flour has been a popular component in the production of new cereal meals due to its bland flavour, attractive white colour, hypoallergenicity, and ease of digestion (Kadan *et al.*, 2003).

Being a rich source of resistant starch and mineral salts like potassium, iron, calcium, magnesium, and sulphur, the manufacturing of raw banana flour provides a great variety of products for the food sector, particularly in bakery goods, nutritional products, and infant meals (Fasolin *et al.,* 2007). The banana's higher starch content as compared to other fruits may be advantageous for the extrusion process. High concentrations of sugar and moisture in the composition, however, might have unfavourable effects on both the process and the final product. The components of bananas vary somewhat depending on their state of ripeness. When bananas mature, starch is mostly converted to non-reducing and reducing sugars (Gamlath, 2008).

The aim of this study was to evaluate the rheological characteristics of blended flours made from amaranth, rice and raw banana in various ratios.

MATERIALS AND METHODS

Materials

The rice and amaranth flours were procured at a local market in Prayagraj. In the lab, a tray drier (Make-SD electronics and model- SD 100) was used to prepare the raw banana powder. After the flours were prepared, they were blended according to a formula, and dough was made to evaluate the rheological properties. While the amount of raw banana powder varied from 2-8% in the blend, the ratios of amaranth and rice flour were kept constant. The trials were carried out at Department of Agricultural Process Engineering, Dr.AS College of Agricultural Engg and Technology, MPKV, Rahuri, Dist. Ahmadnagar, Maharashtra.

Methods

Farinographic Assay

The resistance of the dough to the action of the paddles used to mix the dough is measured using a Farinograph to determine the rheological properties of the flour. After being weighed, a 300 g sample of flour with 14% moisture content was added to the corresponding farinograph mixing bowl. The flour was blended with water from a burette to make dough. The flour was mixed with 1.5 g/100 g salt and a 300 g Brabender Farinograph (Brabender GmbH & Co. KG, Germany) was used to carry out the test in accordance with the recommended procedure (AACC, 2000). The parameters obtained from the Farinogram included the amount of water needed to produce a consistency of 500 BU (water absorption), the amount of time needed to reach that consistency (development time), the amount of time the dough remained at that consistency (dough stability time), and the amount of softening that occurred after 12 minutes.

Extensographic Assay

By measuring the force required to stretch the dough with a hook until it breaks, an Extensograph may measure the stretching qualities of the dough, including its extensibility and resistance to extension. The features of flours prepared from amaranth, rice, and raw banana were examined in this study using an Extensograph-E (Brabender GmbH & Co. KG). In accordance with the standard method (AACC, 2000), this provided information on the energy value (area under the curve, cm2), the resistance to extension (R, BU), the dough extensibility (E, mm), and the R/E value at 30, 60, and 90 min.

Statistical Analysis

Unless otherwise noted, each analysis had been done in triplicate. Analyzing variance in one way (ANOVA) was used to evaluate statistical significance, and results were reported as the mean standard deviation.

RESULTS AND DISCUSSION

Farinographic characteristics of blended flour

A farinograph is a suitable tool for evaluating the dough's ability to mix. It also has been used to assess the dough characteristics of flours in the bakery and milling sectors. An efficient way to forecast processing behavior and manage the food item's quality is to characterize the rheological characteristics of dough.

According to Table 1, the water absorption (500 B.U.) was 75.3% and water absorption (14.0%) was

73.0% for T0 sample. Whereas it is 57.2% and 54.9% for sample T00 respectively. For the composite flour blend, the water absorption values varies with addition of raw banana powder in the flour blend from 76.7% to 80.9% for WA (500 B.U.) and 74.4% to 78.4% for WA (14.0%). The amount of water needed to get typical dough which has consistency of 500 B.U. at the curve's peak is represented by water absorption. The curve's centre will not reach the 500 B.U. line with much more water, but it will cross that line with very little water. As per the Awolu *et al*. (2016), the water absorption is directly proportional to protein content of the dough. Therefore, as the protein content (amaranth) decreases, the water absorption also decreases.

The development time is the interval between the initial water addition and the moment the dough reaches its maximum torque. The water hydrates the components of the flour during this mixing stage, resulting in the development of the dough. As per Table 1, Sample T00 had the minimum development time of 0.3 minute whereas sample T0 had 0.6 minutes. The development time varies with the replacement of raw banana powder with rice flour and amaranth flour but it does not have much impact on formulations of flour blends. Development time for the formulations of flour blends is 0.6 min, 0.8 min, 0.7 min and 0.9 min for sample T1, T2, T3 and T4 respectively. Awolu *et al.* (2016) said that the development time of the dough depends on the speed of water absorption of flour. Hence here also the development time goes increased as the water absorption of the samples increased.

A greater score indicates a stronger dough since stability time measures how strong the flour is. As per Table 1, the T0 sample showed the highest stability 1.9 min as compared to T00 which showed the lowest stability i.e., 0.0 min. Stability of the flour blend goes decreased from T1 to T4 as the rice flour and amaranth flour substituted with raw banana flour. As the raw banana flour has the highest starch content, it affects on the stability of dough. The percentage of raw banana flour increases from sample T1 to T4 and respectively reduces the dough stability. According to Vernaza (2011), the raw banana flour reduces the stability of the dough as it interferes with the protein or preventing its continuity.

The change in barbender units recorded 5 minutes just after apex of the curve is attained is the mixing tolerance index. According to Table 1, Tolerance index was higher for rice flour. It increased from sample T1 to T4 with addition of banana flour i.e., from 172 BU to 272 BU. This happened due to the unavailability of gluten protein in the formulations. As raw banana flour percentage increased, the starch content also increased. In the result, there was no interaction between starch and gluten, hence resulted in higher MTI. As per the Vernaza (2011), the addition of green banana flour caused the significant increase in MTI. And this was due to the addition of green banana flour decreases the tolerance of other flours to mechanical action during prolonged mixing time. Flour's MIT value should be more than 50 B.U. since it suggests more challenges, less mechanical manipulation, and a different dough composition.

Time to breakdown is the period of time, measured to the closest half-minute, as from beginning of the blending process to a reduction of 30 B.U. from the peak point. According to Table 1, sample T0 (amaranth flour), T1 and T2 has highest breakdown time of 0.9 min and sample T00 (rice) has lowest breakdown time i.e., 0.3 min. As the proportion of raw banana powder increased in the formulations the respective time to breakdown of dough also increases from sample T1 to T4. The time required to breakdown of dough was 0.9, 0.3, 0.9, 0.9, 0.7 and 0.6 sec for sample T0, T00, T1, T2, T3 and T4 respectively. As starch content (raw banana flour) increased, the breakdown time also reduces.

Table 1. Farinographic characteristics of blended flour

Sample	Moisture Content (%)	W.A. (500 BU)	W.A (14.0%)	Development Time (Min)	Stability (Min)	Tolerance index (BU)	Time to breakdown (Min)
T0	12.0	75.3	73.0	0.6	1.9	48	0.9
T00	12.0	57.2	54.9	0.3	0.0	187	0.3
T1	12.0	80.9	78.0	0.6	1.0	172	0.9
T2	12.0	80.3	78.6	0.7	0.5	233	0.9
T3	12.0	76.7	74.4	0.8	0.2	260	0.7
T4	12.0	74.7	72.4	0.9	0.2	272	0.6

A common indicator called the farinograph quality number was developed by the Barbender TM Company. According to Table 1, The farinograph quality number was also higher for sample T0, T3 and T4 with related to breakdown time. The farinograph quality number for sample T0, T00, T1, T2, T3 and T4 was 9, 3,6,7,9 and 9 respectively.

Extensographic characteristics of composite flour blend

Extensibility, which is an unaxial load extension curve of the dough test piece subjected to measured stretching of the dough, is an indicator of good dough handling skills. Extensograph analysis offers information on the viscoelastic behaviour of dough and assesses its extensibility and resistance to stretching. A combination of good resistance and good flexibility results in dough with desirable properties. The rheological properties of the dough samples were evaluated using the extensograph (Barbender, Duisburg, Germany), including their resistance to extension (BU), extensibility (mm), and maximum energy required for dough extension. The ratio number might be calculated from various factors.

The samples' values are listed in Table 2. This extensogram curves at 30, 60, and 90 minutes of proving time are displayed. The area beneath the curve i.e., energy value (cm^2) ranged between 20 to 30 cm^2 for samples T0 and T00. The energy area goes decreased as the proving time increases in all the samples. The resistance to extension was higher for amaranth flour i.e. 74 BU at resting time of 30 min. It is higher for the sample T4 and values as 53, 50 and 46 at 30 min, 60 min and 90 min of proving time respectively. The resistance to extension increased from samples T1 to T4 with respect to all mentioned proving time. For the amaranth flour (T0), the extensibility also higher range between 38 and 46 and it was less for the rice flour ranged between 24 and 17. The changes in the stability of the dough occurred due to the interference of the other compounds from raw banana flour in the dough, said by Vernaza (2011).

Similarly in Table 2, the maximum resistance to extension was higher for rice flour (T00) i.e. 1542, 1270 and 1210 at proving time of 30, 60 and 90 minutes. After rice flour sample, it was higher in sample T2 which is ranged from 526 to 518. The maximum resistance to extension also goes decreased with respect to increased proving time. It was less for the sample T4 i.e. 504 BU at 30, 502 BU at 60 and 498 BU at 90 minutes.

Ratio number (R/E) is a comprehensive indication of extensibility and resistance in flour, a higher value signifying stronger resistance and lower extensibility. Harder dough, smaller the expansion. According to Table 2, the ratio number for all the samples were ranged between 0.5 and 3. In samples T0, T2, T3 and T4, the ratio number decreased at 60 min and again increased at 90 min of proving time.

Table 2. Extensographic characteristics of composite flour blend

Samples	Proving time (Min)	Energy (cm^2)	Resistence to extension (BU)	Extensibility (mm)	Maximum resistance(BU)	Ratio Number
T0	30	23	74	46	576	1.6
	60	21	45	38	553	0.5
	90	20	20	46	489	1.0
T00	30	29	48	24	1542	1.1
	60	23	38	19	1270	2.0
	90	22	27	17	1210	2.8
T1	30	35	43	53	526	0.6
	60	33	40	50	521	1.0
	90	30	37	46	518	0.7
T2	30	31	44	50	520	1.8
	60	29	41	47	517	0.8
	90	28	39	43	510	0.7
T3	30	25	48	49	514	0.7
	60	24	45	43	509	0.5
	90	22	42	41	507	1.0
T4	30	19	50	44	504	1.3
	60	18	43	40	502	1.0
	90	15	40	38	498	1.1

From the observations, it was shown that the sample T1 and T3 has lower R/E ratio, resulting in strongly acceptable dough formulation. And the sample T1 and T3 had soft dough compared to other samples.

CONCLUSION

The influence of partial addition of raw banana flour with rice and amaranth flour on the composite flour dough rheological characteristics and quality were investigated. The findings showed that the addition of raw banana flour significantly affected dough rheological characteristics as measured by farinograph and especially extensograph. Based on the analysis of farinograph, the stability time showed the time between 0.2 min and 1.0 min. Compared to the controlled sample, the tolerance index and time to breakdown of dough increased with increased amount of raw banana flour in dough respectively. On the other hand, with the addition of raw banana flour in composite flour blend, greater positive effects were observed in the rheological characteristics of dough. Based on the extensograph, enhancement of resistance to extension, and extensibility values thoughout the 90 min proving time as compared to control sample, suggested that the addition of raw banana flour improves the rheological characteristics and quality of dough. The composite flour needed longer time to evaluate rheological effects on dough as the farinograph requires less time (15 min) to complete than the extensograph (90 min) procedure. Data in this study clearly showed that the rheological properties and the quality of the blended flour dough improved with the addition of raw banana flour.

Conflict of Interest

The author declares that in the current study there is no any conflict of interest.

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