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Effect of incorporating maize flour on the dough characteristics of meat stuffed ball

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Abstract
A study was conducted to prepare value added meat stuffed dough ball (Litti) by filling minced spent hen meat in dough prepared with wheat flour (100%), maize flour (100%) and its combination (50:50). For standardization of dough preparation, functional and proximate composition of dough prepared from different types of flours were evaluated as per standard methods. The mean values of Water Holding Capacity of flours varies from 66.25 to 132.97%, Emulsion stability varies from 7.13 to 19.20% and Foaming Capacity varies from 13.19 to 19.58%. Among proximate composition , moisture varies from 7.32 to 9.23%, Crude protein 8.19 to 9.57%, Fiber 4.66 to 14.37%, Ether extract 4.01 to 5.61% and Ash 3.41 to 4.50%. The 50:50 combination of maize flour and wheat flour (T_3) was found to be higher in crude protein and fiber content over T_1 and T_2 and was found to be most suitable for dough preparation for meat stuffed ball making.

Keywords: Gluten, maize flour, meat stuffed dough ball, wheat flour

Introduction
Stuffed dough ball (Litti) is a traditional and most popular street food of states like Bihar, Jarkhand and some parts of Uttar Pradesh. Generally, it is prepared by filling gram flour inside dough prepared from wheat flour. Many researchers had found that whole wheat flour is a good source of functional ingredients such as fiber, photochemical, minerals, essential amino acids that are located in the bran and fat soluble vitamins contained in the germ of the whole wheat grain (Dewettinck *et al*, 2008) [6]. Wheat is mostly used for dough making because, wheat bread is now one of the most representative food in the world (Yano, 2019) [13]. Due to the high cost and demand, geographical scarcity and high demand of wheat flour, efforts are been directed toward the provision of locally available alternative source of flour such as maize, cassava, oats etc. (Begum *et al*., 2013) [3]. Apart from this, another reason for less consumption of wheat flour is due its gluten content. Different water-soluble (albumin and globulin) and insoluble (glutenin and gliadin) component of wheat proteins in addition to nonspecific lipid transfer protein, and inhibitors of α-amylase and trypsin inhibitors (ATIs) can lead to the production of wheat allergy (Mirjalali and Tavakoli, 2022) [10]. Gluten-free diet is generally recommended for the management of celiac disease (CeD) and other gluten related disoders (GRDs); which entails that no gluten-containing food, beverages, or medications may be ingested (Al-Toma and Mulder, 2022) [1]. Therefore maize is a good alternative source for dough preparation to replace wheat. Although maize as compared to wheat and rice is higher in fat, iron and fiber content but low in quality of its protein since around a half of its protein is made up of zein, which is deficient in two essential amino acids, lysine and tryptophan. So, for balancing of nutrient content flour combination may be a possible solution. Therefore the study was conducted with objective to evaluate suitability of dough with wheat flour, maize flour and its combination for making meat stuffed dough ball.

Materials and Methods
Preparation of flour dough
Three types of flour dough formulations were prepared. Type I containing 100% wheat flour(T1) , Type II containing maize flour 100% (T2) and Type III contain 50:50% wheat flour and Maize flour (T3) along with addition of salt 2%, refined oil 5% and water as per requirement. The Dough was prepared using 200 gm flour with other ingredients and mixed in the Mixer (Spar Mixer). After proper mixing, three types of dough were prepared separately and were evaluated for their quality parameters. The dough having best quality parameters was used for preparation of stuffed dough ball (litti).

Moisture, protein, fat and ash content were determined by the method of Official Analytical Chemists (AOAC, 1995) [2].

Moisture

Moisture content was determined by Oven drying method.

Moisture content was determined according to the method of Association of Official Analytical Chemistry (AOAC, 1995) [2]. The minced meat sample (5 gm) was transferred in pre-weighed flat bottom aluminium dish, which was transferred to hot air oven 101±1 °C for 16-18 hr. dried sample was then placed in desiccators having silica gel as desiccant. After 1 hr, the dish was weighed. Moisture content was calculated by applying the following formula:

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

Where

W_1 = weight of empty dish

W_2 = weight of dish+sample

W_3 = Weight of Dish+Dried sample

Protein

Protein content was determined by modified Kjeldhal's method. The sample (2-2.2 gm) was digested using Micro-Kjeldhal digester in the presence of catalyst (95-part sodium sulphate/potassium Sulphate+5-part copper Sulphate) and 40ml sulfuric acid. Flask was placed in inclined position and heated gently until frothing ceased then boiled rapidly until solution became clear, the sample (10ml) was diluted with 10ml of 40% NaOH using Micro- Kjeldhal distillation unit. Steam was distilled over 2% boric acid (25ml) containing mixed indicator (1 part 0.2% methyl red+2 Part 0.2% bromocresol green dye) for 10 min. The ammonia trapped in boric acid was determined by titrating with 0.1 N sulfuric acid. The nitrogen percentage was calculated using the following formula:

$$\text{Nitrogen (\%)} = \frac{\text{(A-B) X Total Volume made}}{\text{Wt. of the sample taken x Volume distilled}} \text{ X } 100$$

A = Titrated value for sample

B = Titrated value for blank

Protein percentage was determined by conversion of nitrogen percentage to protein by using conversion factor (6.25) assuming that all the nitrogen in meat was present as protein i.e.,

Protein percentage = N% X CF.

Where

N= Nitrogen

C F= Crude Fibre

Ether Extract

Fat content was determined by ether extraction method using Soxhlet's apparatus. In Soxhlet's appatatus, the lipids were extracted with a suitable solvent such as petroleum ether. Stuffed dough ball sample (3 g) was taken into fat free extraction thimble, dried in oven for 6 hr. Soxhlet Extractor was set with reflux condenser and oil flask which was previously dried and weighed. The petroleum ether was then evaporated off and the lipid was dispersed in a toluene-alcohol mixture and titrated with standard potassium hydroxide. Fat content was calculated by using the following formula.

$$\text{Fat (\%)} = \frac{W_2 - W_1}{W_3} \text{ X } 100$$

Where

W_1 = weight of empty oil flask

W_2 = weight of oil flask+Fat

W_3 = Weight of sample taken

Ash

Ash percentage was determined by gravimetric method as described by AOAC (1995) [2] using Muffle furnace. The fresh minced stuffed dough ball sample (5-10 g) was transferred in a pre-weighed crucible and transferred to Muffle furnace at (550 °C) for 4-5 hr. Ashed sample was transferred to desiccator having silica gel as desiccant. After 1 hr, the crucible was weighed. The ash content was calculated by the following formula

$$\text{Ash (\%)} = \frac{\text{Wt. of Ashed sample}}{\text{Wt. of the sample taken}} \text{ x } 100$$

Fiber

Fiber content in the sample was measured by using an enzymatic-gravimetric method.

Functional properties of Dough

Water holding capacity (WHC)

The WHC of the samples were determined by using the methods suggested by Beuchat (1977) [4]. The 1 gm flour and 10 ml was vortexed with 10 ml distill water in centrifuse tube for 30 minutes. After standing at room temp. for 30 minutes, the sample was centrifused for 25 minutes at 3000xg. The sediments were weight after complete removal of the supernatant were determined by using the methods suggested by Beuchat (1977) [4]. The flour/blend (1 g) was vortexed with distilled water (10 mL) in pre-weighed centrifuge tube for 30 minutes. After standing at room temperature for 30 minutes, the sample was centrifuged for 25 min at 3000 × g. The sediments were weighed after complete removal of the supernatant. For the determination of OHC, the flour/blend (0.5 g) was homogenized with canola oil (5 mL) in pre-weighed centrifuge tube and proceeded further as described for WHC. The WHC and OHC (%) were calculated as:

$$\text{WHC \%} = \frac{W_2 - W_1}{W_0} \text{ X } 100$$

Where

W_0 = weight of sample

W_1 = weight of centrifuse tube plus sample

W_2 = weight of centrifuse tube plus sediment

Emulsion stability

The emulsion stability was determined by the method of Yasumatsu *et al*. (1972) [14]. 1 g flour sample, 10 mL distilled water and 10 mL vegetable oil was taken in calibrated centrifuge tube. The emulsion stability was estimated after heating the emulsion contained in calibrated centrifuged tube at 80 °C for 30 min in a water-bath, cooling for 15 min under running tap water and centrifuging at 2000 × g for 15 min.

The emulsion stability expressed as percentage was calculated as the ratio of the height of emulsified layer to the total height of the mixture.

Foaming Capacity

The foam capacity (FC) by (Narayana and Narsinga Rao 1982) [12] were determined as described with slight modification. The 1.0 g flour sample was added to 50 mL distilled water at 30 ± 2 °C in a graduated cylinder. The suspension was mixed and shaken for 5 min to foam. The volume of foam at 30 s after whipping was expressed as foam capacity using the formula:

$$\text{Foam capacity (\%)} = \frac{\text{Volume of foam AW} - \text{Volume of foam BW}}{\text{Volume of foam BW}} \text{ X } 100$$

Where, AW = after whipping, BW = before whipping

Were determined by using the methods suggested by Beuchat (1977) [4]. The flour/blend (1 g) was vortexed with distilled water (10 mL) in pre-weighed centrifuge tube for 30 minutes. After standing at room temperature for 30 minutes, the sample was centrifuged for 25 min at 3000 × g. The sediments were weighed after complete removal of the supernatant.

Results and Discussion

This experiment was conducted in order to find out the suitable proximate and functional characteristics for dough preparation. Two types of flours were compared separately and also with the mixture of flour in the 50:50 ratio and were evaluated for following proximate and functional characteristics of their dough.

Proximate characteristics of flours

The values of moisture content for two different flours and its combination were varied from 7.32 to 9.23%.The mean values recorded were 9.23%, 7.32% and 8.40% in wheat flour, maize flour and mix. flour respectively. Table 1 showed that moisture content is lowest in maize flour and highest in wheat flour, while the combination of both flour in 50:50 ration has moisture intermediate between the two different flours. Similar trends were reported by Kaushal *et al.* (2012) [8]. They used the blends of taro, rice and pigeon pea flour with wheat flour, which resulted in reduction of moisture content of composite flours than whole wheat.

The values for CP % varied from 8.19 to 9.57%.The mean values of CP % were recorded as 8.19%, 9.14% and 9.57% in wheat flour, maize flour and mix. flour dough respectively. The mean value obtained was highest for mix. flour followed by maize flour and wheat flour dough. The results were as expected owing to the higher amount of protein content in maize flour and mix. flour than whole wheat flour. Gómez *et al.* (2008) [7] reported an increase in protein content of cakes by incorporation of chickpea flour in wheat flour.

The values of fiber (%) varied from 4.66 to 14.37%.The mean values of fiber % were recorded as 13.10%, 4.66% and 14.37% in wheat flour, maize flour and mix. flour dough respectively. The mean value obtained was highest for mix. flour followed by wheat flour dough and lowest for maize flour. The fiber content of all the treatment differed significantly (p<0.05) from each other. This might be due to different flour quality and proportions. The values for Ether Extract varied from 4.01 to 5.61%. The mean values of EE were recorded as 5.61%, 4.01% and 4.65% in wheat flour, maize flour and mix. flour respectively. The mean value obtained was highest for wheat flour followed by mix. flour and lowest for maize flour. Ether extract represent the amount of free fatty acid in the product. The level of free fatty acid is a good measure of the storage conditions of the flour. Flours with high levels of free fatty acids will be more subjected to rancidity than the flours having low fatty acid. In this finding, T_2 has lowest EE value followed by T_3 and T_1.The values for Ash % varied from 3.41 to 4.50%. The mean values of Ash % were recorded as 4.50%, 3.41% and 3.70% in wheat flour, maize flour and mix. flour dough respectively. Table 1 shows that Ash content was highest for wheat flour followed by mix. flour and lowest for maize flour. As maize flour contain lowest percentage of ash but its combination with wheat flour significantly increases the level of ash content in the mix. T6. The similar results have been reported by (Mojisola *et al*., 2005) [11] for maize soybean blend. The percentage of ash content increased significantly with increase in the fortification of flours. This may be due to that non-endosperm parts of the kernel (pericarp, aleurone, and germ) are very high in ash when compared to the endosperm. Thus, the ash content is a sensitive measure of the amount of non-endosperm material that is in the flour.

Functional properties of flours

Mean values of water holding capacity, emulsion stability and foaming capacity of different types of dough are presented in Table 2. The mean value of water holding capacity of dough varies from 66.25 to 132.97. Maize flour has highest water holding capacity (132.97) followed by mix flour dough (90.75) and lowest for wheat flour (66.25). Water acts as the reference solvent since it can hydrate and swell gluten, damaged starch and arabinoxylans of flour (Kweon *et al*, 2011) [9]. High WHC determines the hydrophilic nature and high hydrozen bonding of protein molucles. Therefore high WHC of maize flour make it superior than wheat flour and so the mix. prepared with the combination of wheat and maize flour was found to be better for product prepared with respect to its texture and other quality than the dough ball prepared from wheat flour only.

Table 1 showed that values for emulsion stability of different flour dough varies from 7.13 to 19.28. Minimum emulsion stability was recorded in dough prepared from wheat flour (7.13%) followed by wheat: maize flour mix 50:50 (10.56%) and only maize flour (19.28%). All the three flour dough were significantly (p<0.01) different from each other.

Hydrophobicity of protein has been attributed to influence their emulsifying properties (Kaushal *et al*., 2012) [8]. The formation of disulfide bonds, hydrogen bonds, and hydrophobic interactions stabilize the gluten structure during the dough mixing process (Chiang *et al*., 2006) [5].

The foaming capacity of a food or flour is measured as the amount of interfacial area created by whipping the food or flour. Protein is mainly responsible for foaming. Foaming capacity and stability generally depend on the interfacial film formed by the proteins, which maintains the suspension of air bubbles and slows down the coalescence rate. The foaming capacity of different dough varies from 13.19 to 19.58%. Wheat flour has highest foaming capacity (19.58%) and maize flour (13.19%) has lowest, while mix flour dough has intermediate between them (16.25%).

Highest foaming capacity in wheat flour dough is due to higher protein content. Protein in the dispersion may cause a lowering of the surface tension at the water air interface, thus always been due to protein which forms a continuous cohesive film around the air bubbles in the foam (Kaushal *et al.*, 2012) [8]. Due to low foaming capacity of maize flour, it would be better to use it with combination of wheat flour to prepare product like stuffed dough ball (litti).

Table 1: Proximate characteristics of flours for dough of stuffed ball

Parameters	T_1 (100% Wheat flour)	T_2 (100% Maize flour)	T_3 (50:50: Wheat: Maize mix.)	F Value
Moisture (%)	9.23^c+0.52	7.32^a+0.12	8.40^b+0.09	105.889
CP (%)	8.19^a+0.56	9.14^b+0.32	9.57^c+0.06	171.119
Fiber (%)	13.10^b+0.46	4.66^a+0.06	14.37^c+0.05	8151.935
EE (%)	5.61^c+0.08	4.01^a+0.05	4.65^b+0.03	87.287
Ash (%)	1.50^a+0.04	2.41^b+0.04	2.70 ^{c}+0.07	158.438

Table 2: Functional characteristics of flours for dough of stuffed ball

Parameters	T_1 (100% Wheat flour)	T_2 (100% Maize flour)	T_3 (50:50: Wheat: Maize)	F Value
Water Holding Capacity (%)	66.25 ^{c}+1.18	132.97 ^{a}+3.52	90.75 ^{b}+1.45	213.95
Emulsion Stability (%)	7.13^c+0.13	19.28^a+0.41	10.56^b+0.21	504.61
Foaming Capacity (%)	19.58^{a+}0.19	13.19^c+0.12	16.25^{b+}0.23	285.80

Conclusions

Based on the results obtained on the various parameters studied in this investigation, it may be concluded that combination of wheat flour and maize flour (50:50) could be most suitable for dough making over wheat flour or maize flour only. This combination is most suitable to improve the quality, texture and overall acceptability of the product.

Conflict of Interest

There is not any conflict of interest.

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