

Original Research Article

<https://doi.org/10.20546/ijcmas.2019.809.207>

Optimization and Quality Evaluation of Pasta Utilizing Corn Grits By-Product (Hominy Flour)

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ABSTRACT

Keywords

Replacement-
Dietary fibre-
Hominy flour-
Quality
Characterisation

Article Info

Accepted:
20 August 2019
Available Online:
10 September 2019

In this study, corn grit by-product (hominy flour) is used as a replacement of durum wheat semolina in pasta (macaroni). Hominy flour is used as a feed ingredient in livestock, poultry, etc. and is found to be a good source of protein and dietary fibre. Trials were made in such a way to replace durum wheat semolina such as 10%, 20%, 30%, 40% and 50% and quality assessment along with typical characteristics of pasta were tested. Different Pasta blends have been compared with the control pasta and quality characterisation of pasta is evaluated. It has been found that 30% replacement has good sensory acceptance with 9.45-9.57% of Dietary fibre.

Introduction

In the current era of globalization there is a worldwide shift in the diet plan. This shift is from a diet dominated by staples-mainly coarse grains and other partially processed grains, vegetables and legumes to one where processed foods predominate and animal source foods represent a far greater proportion of all calories (Drewnowski A, 1997). The

diets which we consume nowadays are high in fats, saturated fatty acids, sugar and salt. Cumulative effect of lifestyle and food habits has manifested itself as obesity, hypertension, high cholesterol, cardiovascular disease, diabetes, impaired pancreatic function and osteoporosis. Thus, the time is right for optimizing health by the use of functional foods. Whole grains contain endosperm, germ, and bran. Whole grains are rich in nutrients

and phytochemicals with more known, documented health benefits (Slavin J, 2004) and are rich in dietary fibre, resistant starch, and oligosaccharides. It is also rich in antioxidants including trace minerals and phenolic compounds and these compounds have been linked to preventing diseases. In order to maintain these components in the end-products, whole grain flours and/or fortified flours are recommended for the production of health enhancing foods or functional foods which has great demand among current generation due to change in lifestyle.

With increase in urbanization, industrialization and change in life style, consumers are looking forward at snacks and foods which are more convenient to process which is also good source of nutrition and currently demand for low-calorie and low-sugar foods are in hike now. Nutritional benefits are particularly enhanced when grains are used for food preparations.

Production of formulated food such as pasta with high protein and fibre can give many health benefits to people. Pasta is a good carrier to supply nutrition for the health-conscious consumers. Pasta is one of the greatest processed food made from grains. The term "Pasta" originated from Greek and Latin which means "Barley Porridge" in Greek and "Dough Pastry cake" in Latin. In Italy it is termed as "Paste" because of the way it is made by mixing flour, water and ingredients required. There is a typical thinking that Pasta is invented in Italy but the first recorded reports of people consuming pasta is from China as early as around 5000 B.C. Pasta may have its origin in Asia and Mediterranean but growing popularity of pasta has made it a healthy food worldwide. Pasta products such as macaroni, spaghetti and noodles are very popular in Europe and in Western Hemisphere. Approximately 13.6 million tons

of pasta is produced worldwide with an estimate of 100,000 tons production in India (www.pasta-unafpa.org). As per International Pasta organization, 600 different shapes of Pasta are produced throughout the globe.

In India, the use of pasta products particularly noodles have increased to more than unexpected level and even market competition has increased significantly to another level.

Important quality of pasta is that it liberates the sugars slowly, which body needs progressively. In India Pasta products such as macaroni, spaghetti, vermicelli and noodles are manufactured from semolina and flour produced from durum wheat. This is because wheat proteins such as gliadins and glutenins which have properties in which interaction between semolina and other components, mainly lipids, to form a very specific viscoelastic lipoprotein complex called gluten when mixed with semolina and water are mixed together (Kaur G, 2009). These products are becoming popular in current lifestyle because they are healthy, tasty and convenient for transportation and preparation (Cubadda R, 1994)

In India, Corn (*Zea mays*) has become the third most important food grain after wheat and rice. It has high-energy value and is used for human food and animal feed. Corn flour is used to make nutritious products which are highly palatable and are easily digested by the body.

When taken at different intervals, its proven that it helps to clean the colon. The use of maize also helps to combat the effects of certain cancers, as it reduces the development of colon cancer. In view of the aforesaid points, the present study was focused on the use of un-exploited corn grits by-product for production of ready-to-cook pasta product using cold extrusion technology.

Materials and Methods

Raw material

Durum wheat semolina was purchased from local market (Kundli) and the Corn grit by-product was collected from a Corn processing industry (Sun-up Agro processing Pvt Ltd). It was grinded, sieved and the particle size was reduced to 250 μ using sieve.

Equipments

Laboratory scale pasta maker (La Monferrina, Italy) was used for making pasta and Lab scale tray dryer was used in this.

Optimum Cooking Time

Optimum cooking time was determined using AACC(2000). Trials made T1=10%, T2=20%, T3=30%, T4=40%, T5=50% and control (semolina 100%) were used for measuring the optimum cooking time required to cook pasta. 10g pasta sample was weighed and boiled in 200ml of distilled water.

Cooking loss

Cooking loss is the amount of loss in pasta happened during cooking and it was measured as % loss. The desirable characteristic of pasta is that cooking loss should be less than 12%.

It was calculated by transferring the water which was used for cooking the pasta into pre-dried, weighed beaker and the water was allowed to get dried completely in a hot-plate. It was then allowed to cool in a desiccator. Final weight of the beaker was noted. Cooking loss was calculated using the formula below:

$$\text{Cooking loss (\%)} = \frac{100 * (W2 - W1)}{W}$$

Where W1 is weight of the empty beaker, W2 is the weight of the beaker after drying and W is the weight of the sample taken in gram.

Water absorption index

Water absorption of pasta was calculated by weighing the raw pasta and cooking the pasta to optimum cooking time. The weight of cooked pasta was also noted. It was calculated using the formula:

$$\text{Water absorption index (\%)} = \frac{\text{weight of cooked pasta} - \text{weight of raw pasta}}{\text{weight of raw pasta}} * 100$$

Swelling index

It is the water uptake of dry pasta per gram. It was done by drying the cooked pasta at 105°C until the constant weight was obtained. It was evaluated using the formula:

$$\text{Swelling index} = \frac{\text{weight of cooked pasta} - \text{weight after drying}}{\text{weight after drying}}$$

Moisture content

Moisture content was determined by the gravimetric method as described in AOAC (1990)

Ash

Muffle furnace was used to determine the ash content in the product as described in AOAC, 1990. The total ash content was determined by weighing accurately about 5 g of the sample in previously heated and cooled silica/porcelain dish. The samples were charred/pre-heated over a hot plate or flame and then placed in muffle furnace at 545 \pm 5°C for three hours or till ash is obtained.

$$\text{Ash (\%)} = \frac{W2 - W1}{W} * 100$$

Where W1 is empty weight of the crucible, W2 is the weight of the crucible and sample after ashing and W is the weight of the sample taken in gram

Crude Protein

Dry pasta sample was grinded using mortar and pestle. 1g of the sample was taken in Kjeldahl tube. The kjeldahl tube was placed in micro-digestion unit. Once the digestion was completed, the kjeldahl tube was placed in distillation unit. The various nitrogenous compounds were converted into ammonium sulphate by boiling with concentrated sulphuric acid. The ammonium sulphate formed was decomposed with an alkali (NaOH) and the ammonia liberated was absorbed in excess of standard solution of acid and then back titrated with standard alkali. The nitrogen value was multiplied by 6.25 to obtain the protein content.

$$\text{Protein (\%)} = \frac{14 \times \text{titre value} \times \text{Normality of HCL} \times 6.25 \times 100}{\text{sample weight} \times 1000}$$

Crude fat

Dry pasta sample was crushed and grinded using mortar and pestle. 5g of the powdered sample was taken in what mann filter paper and placed in pre-dried, weighed glass thimble. The thimble was then filled with 3/4th of petroleum ether and the Soxhlet unit was switched on.

Once the process was completed, the glass thimble was placed in hot air oven at 80-85°C/30min. this process was done to evaporate the residues of petroleum ether if present any. The final weight of the thimble was noted. Crude fat was calculated using the formula:

$$\text{Crude fat (\%)} = \frac{\text{final weight} - \text{initial weight}}{\text{sample weight}} \times 100$$

Dietary fibre

For estimation of dietary fibre IS 11062:1984 method was followed. Samples were sent to Apex Testing and Research laboratory, New Delhi.

The total dietary fibre was estimated using the formula

$$\text{Total dietary fibre} = \frac{(\text{Mass of soluble fraction} + \text{Mass of Insoluble fraction})}{\text{Mass of sample}}$$

Colour

Colour of the Pasta samples at different trials were measured individually by using hand hold Chroma-meter (KONICA MINOLTA, CR-400, JAPAN) and was read as L*, a* and b*. L* represents light dark spectrum with a range from 0 (Black) to 100 (white). While a* is the red-green spectrum with a range from -60 (green) to +60 (red) and b* indicates yellow- blue spectrum with a range from -60 (blue) to +60 (yellow). Initially the calorimeter was calibrated by placing the tip of measuring head flat against the surface of the white calibrated place. After this the values of L*, a*, b* and ΔE^* of pasta was measured as total colour difference (ΔE) was calibrated as Equation:

$$\Delta E^* = \sqrt{((L^*)^2 + (a^*)^2 + (b^*)^2)}$$

Results and Discussion

The effect of cooking over the pasta quality in terms of cooking loss, water absorption power and swelling index of the pasta made out of durum wheat semolina and Corn grits by-product is given in Table 1. Significant variation was observed in the minimum cooking time of pasta. Control pasta (100% durum wheat semolina) took 07:05min for complete gelatinization of starch on cooking.

It was determined as the time when the white inner core of the pasta disappeared when placed/compressed between two glass slides. Decrease in cooking time was observed as the amount of wheat semolina decreased and proportion of Corn grit by-product is increased.

In Pasta Formation, the protein matrix is crucial factor. If it is being disrupted by adding other additives, it will negatively affect cooking quality leading to a decreased optimum cooking time (Chillo S *et al.*, 2007 and Chillo S *et al.*, 2008b) and it also leads to increase in cooking loss (Ugarcic-Hardi Z *et al.*, 2003 and Sabanis D *et al.*, 2006). It is evident from table 2, that the optimum cooking time gets decreased if the semolina is replaced by Corn grits by-product and it is also clear that the cooking loss gets increased, swelling index and Water absorption index also gets increased after replacement of durum wheat semolina. Water absorption index is increased as the semolina is replaced. As water absorption increases it leads to relatively stable dough.

There is a significant rise in the volume expansion over control (100% wheat) pasta was observed which is described in Table 1. As the level of Corn grit by-product is increased in the blends the protein content also increased.

Significant differences were observed for colour values of $L^*a^*b^*$ among the Pasta which was shown in table 2. L^* value corresponds to lightness of the product. Lightness of pasta decreased with the addition/replacement of Corn grits by-product from 10% to 50% (68.84 ± 0.04 to 59.40 ± 0.10). The parameter a^* denotes the balance between green (negative values) and red (positive values). As the addition of corn

grits by-product along with semolina it increases a^* value, it might be due to addition of proteins, which causes a^* parameter to shift towards small positive (Ziobro *et al.*, 2013). The b^* is the function of the green blue difference. Positive b^* indicates yellowness, negative b^* indicates blueness. As the percentage of Corn grit by-product is increased in the blends, the b^* value also increased from 21.63 ± 0.16 to 22.88 ± 0.14 .

The hue angle is used to characterize colour in food product. Perfect angle of 90° , represents the light-yellow colour of the product. Addition of corn grits to semolina decreased the darkness of pasta as compared to control.

Mean sensory panel score for the pasta prepared by substituting corn grit by-product at different levels were evaluated by semi-trained panel of 25 judges on 9-point hedonic scales given in Table 3. The proximate composition of the raw material along with the Control and trial samples was given in table 4.

The results exhibited non-significant difference between the trials. Crude protein was found to be high in pasta incorporated with corn grit by-product than the pasta made with durum wheat.

The Corn grit by-product Pasta which is used for replacement of semolina was comparable with control pasta (100% Durum wheat semolina) in terms of physicochemical properties and acceptability.

Corn grits by-product can be added up to 30-40 percent without adversely affecting the quality attributes of pasta. Therefore, by-product utilisation for making of nutritious pasta is a newer direction for convenience and value addition

Table.1

Sample	Optimum cooking time (min)	Cooking loss (%)	Water absorption index (%)	Swelling index g/g
Control	07:05±0.07	5.76±0.21	107.6±0.19	2.8±0.25
T1-10%	06:25±0.09	7.78±0.12	115.7±0.05	3.5±0.20
T2-20%	06:05±0.09	9.24±0.15	120.2±0.25	4.4±0.22
T3- 30%	05:53±0.10	11.41±0.05	124.4±0.12	4.8±0.29
T4- 40%	05:41±0.02	13.16±0.10	132.1±0.09	4.2±0.22
T5- 50%	05:25±0.05	15.27±0.20	134.9±0.11	4.3±0.18
F Value	2.73*	5.12**	9.74**	2.59*

@ Average of six trials

NS-Non-Significant (P>0.05); * - Significant (P<0.05); ** -Highly significant (P<0.01); Mean Values bearing different superscripts in a row differ significantly

Table.2

Sample	Mean Tri-stimulus Colour Values			ΔE*	Hue Angle (°)
	L*	a*	b*		
Control (100% semolina)	68.44±0.09	0.45±0.07	20.96±0.18	35.4±0.12	88.76±0.24
T1 10%	68.84±0.04	0.07±0.15	21.63±0.16	35.3±0.18	89.79±0.21
T2 20%	66.81±0.15	1.40±0.10	23.72±0.15	38.0±0.21	86.62±0.17
T3 30%	62.85±0.01	2.10±0.05	24.08±0.10	42.2±0.17	85.01±0.16
T4 40%	61.58±0.10	1.81±0.14	21.56±0.15	42.4±0.13	85.20±0.13
T5 50%	59.40±0.10	1.55±0.13	22.88±0.14	38.1±0.12	86.11±0.12
F Value	6.97*	4.25*	4.46*	3.41*	8.77*

@ Average of six trials

NS-Non-Significant (P>0.05); * - Significant (P<0.05); ** -Highly significant (P<0.01); Mean Values bearing different superscripts in a row differ significantly

Table .3

Attributes	Control	T1 10%	T2 20%	T3 30%	T4 40%	T5 50%	F Value
Appearance	7.7±0.11	6.9±0.08	7.2±0.09	7.5±0.10	6.6±0.17	6.2±0.10	1.25 ^{NS}
Taste	7.1±0.11	6.9±0.10	6.7±0.11	6.6±0.10	6.3±0.11	6.0±0.08	0.71 ^{NS}
Texture	7.2±0.09	6.8±0.07	7.0±0.21	7.0±0.18	6.6±0.15	6.0±0.13	0.89 ^{NS}
Mouthfeel	7.2±0.10	6.7±0.12	6.8±0.18	6.9±0.15	6.3±0.16	5.7±0.07	1.02 ^{NS}
Overall acceptability	7.6±0.18	6.9±0.11	7.0±0.12	7.2±0.11	6.4±0.17	5.9±0.07	0.73 ^{NS}

@ Average of six trials

NS-Non-Significant (P>0.05); * - Significant (P<0.05); ** -Highly significant (P<0.01); Mean Values bearing different superscripts in a row differ significantly

Table.4

S. No	Constituents	Corn Grit By-product (Hominy flour)	Control Pasta (100% durum wheat semolina)	Semolina and Corn Grit By-product Pasta (30%)	F Value
1	Moisture content	11.04±0.08	11.08±0.11	11.02±0.17	1.75 [*]
2	Ash content	1.92±0.05	1.80±0.12	2.15±0.17	0.093 ^{NS}
3	Crude Fat	6.28±0.12	1.22±0.12	2.02±0.09	5.42 [*]
4	Crude Protein	4.70±0.15	2.58±0.22	12.53±0.11	24.70 [*]
5	Total Dietary Fibre	3.12±0.010	2.77±0.25	9.47±0.21	19.95 [*]

@ Average of six trials

NS-Non-Significant (P>0.05); * - Significant (P<0.05); ** -Highly significant (P<0.01); Mean Values bearing different superscripts in a row differ significantly

Acknowledgement

The authors acknowledge the help provided by the Department of Basic and Applied sciences and Department of Food Engineering, National Institute of Food Technology Entrepreneurship and Management for utilizing the lab facilities for analysis, physical parameters and quality control analysis.

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How to cite this article:

Ram Mohan M., N. Sahana and Bhaswati Bhattacharya 2019. Optimization and Quality Evaluation of Pasta Utilizing Corn Grits By-Product (Hominy Flour). *Int.J.Curr.Microbiol.App.Sci*. 8(09): 1793-1800. doi: <https://doi.org/10.20546/ijcmas.2019.809.207>