International Journal of Food Science and Nutrition
ISSN: 2455-4898; Impact Factor: RJIF 5.14
Received: 19-04-2020; Accepted: 20-04-2020; Published: 03-06-2020
www.foodsciencejournal.com
Volume 5; Issue 3; 2020; Page No. 34-37

Technological optimization of processing parameters for the Effect of corn grits on the sensory characteristics of corn puffed products

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Abstract
The main objective is to remove the corn flour coating from corn grits in order to enhance corn puff quality. Yellow dent corn grits are being sized down to centered broken to 3.4mm to 5.6mm. The initial processing corn grit bags have around 6% of the total weight. This corn flour covered over the corn grits mainly affects the product color and flavor absorption increases the cooking cycle time. Process steps of producing the corn grits from corn cob has been detailed and insect manifestation studies have been carried out to random sample from 5 different corn bags. Sieve analysis, cooking cycle time analysis, flavor absorption study, tempering and sensory analysis is done. The results show that corn grit size of 5 to 5.5 mm made better product and soaking the grits for a periodic time breaks the protein complex structure, removes the sticking flour also from corn grits thereby reduces the oil content, neutral detergent fiber (NDF).

Keywords: corn grits, analysis, corn puff

1. Introduction
Maize is a cereal grain first cultivated by indigenous people in Mexico about 1000 years ago. The stalk leaf produces the pollen inflorescences and separate ovuliferous inflorescences called ears that gives corn kernels or seeds, that which are fruits which is consumed by human beings. And they are mainly used for corn flakes, corn flour, corn syrup, corn puffs. The corn kernels are the fruits of corn, which comprises of endosperm, germ, pericarp and tip cap. The kernels are available in tons in cultivating zones. And the pericarp (fruit wall) is fused to seed coat. 82% od kernel is of endosperm; hence starch is the most primary source, and widely used part. The germ is the embryo, the only living part of corn kernel, which consists of vitamins, enzymes and minerals for the plant to grow. The pericarp protects the moisture content and nutrient value. The kernel's attachment point is tip cap to corn cob where water and nutrient flows.
Extrusion is one of the pioneer processes which paved way for modern food technology. Its usage has been tremendously increased in past decades. The extrusion processes simple, affordable and advantageous effective process which can produce products of required shape and size without change in quality. Corn puff are produced in large scale by extrusion process. Corn puff is a snack that has attained a massive welcome and consumption by all age groups. Corn puff are made using corn grits, rice, wheat, or other cereals and are flavored with onion, chilly, cheese, spices, garlic powder etc. Its appearance resembles popcorn. There are more varieties of popcorn that vary between lower lightness, specific length, bulk density, higher redness, lower yellowness, lower gumminess, springiness and chewiness. The acceptance of corn puff majorly depends on the color, appearance, texture and flavor. The appearance factors are mainly its diameter, homogenous structure and porosity. The texture factors depend on the mechanical behavior of extruder and the ingredients.
The desired product can be obtained by controlling the composition of the raw materials and the processing conditions during extrusion.

2. Materials and Methods
2.1 Sample Collection
The corn grits were collected randomly from different corn grit bags from a cereal products manufacturing industry and was tested for particle size distribution, moisture content, tempering, neutral detergent fiber, starch, crude protein, SEM (Scanning Electron Microscope), texture and color analysis. The data were collected and recorded regularly.

2.2 Methods of Analysis
2.2.1 Particle size distribution
The particle size distribution is nothing but sieve analysis (or gradient test) is the procedure followed to assess the corn grit size also called as gradation or granular material. This analysis determines the relative properties of different grain sizes as they are distributed among certain size ranges. This test is carried out by using Vibratory Laboratory Sieve Shaker using sieve mesh size 100, 70, 50, 35, 30, 20, 14. The sample was shaken for 10 min after test grit retain on each sieve is weighed, percentage material retain is calculated. Then the cumulative mass fractions retained were calculated for each sieve [41].

2.2.2 Moisture content determination and tempering:
The moisture content of corn grits was determined by drying the samples in hot air oven at 135 °C for 2 h (AACC international approved method 44-19.01). Corn samples (100 g) and requisite amount of tap water at room temperature were added to 4 L cylindrical plastic plates. Corn samples were tempered by soaking the corn grits in 500ml of water for varying time and maintained at constant room temperature [25].

2.2.3 Analytical tests
The cooked corn grits were selected for testing. Neutral detergent fiber (NDF) content was determined using the procedure of Van Soest *et al*. (1991). Starch content in the ground corn grits was determined using acid hydrolysis method (Vidal *et al*. 2009). Briefly, about 1 g of ground corn samples (~1 g) were mixed with 50 mL dilute HCl (0.4 N) in 100 mL autoclavable bottles, and the slurry was autoclaved at 126 °C for 1 h (Napco Model 9000D, Thermo Fisher 157 Scientific, Waltham, MA) [22].

2.2.4 Morphological observation of corn grits
The raw material and soaked corn grits are taken for Morphological observation corn grits performed using Scanning Electron Microscope (SEM) JEOL JSM6510LA. The focus of the observations is made on the horny endosperm grits and observed without any coating with a magnification of 1000 times. Observations were made on corn grits after incubated under various concentrations and incubation time [23].

2.2.5 Texture analysis
The textural properties of the puff product were measured by a texture analyzer equipped with a 50 kg load cell. The hardness, work of compression, crispiness and crunchiness of the puff product were measured using a 45 mm cylinder probe (P/45R) by compressing 10 individual flakes at one turn. The hardness is defined as the maximum force during the sample compression. The maximum force and work of compression correlate to the hardness of the sample. The crispness is defined as the number of force peaks during the sample compression. The crunchiness is defined as the linear distance in the selected region of the compression curve, which actually represents an imaginary line joining all points of the multi-peak compression curve. The longer the linear distance the crunchier the product. The following settings were used: pre-test speed, 2 mm s-1; test speed, 2 mm s-1; post-test speed, 10 mm s-1; distance, 2.5 mm; trigger force, 10 g×g [26].

3. Results and discussion
On comparison of previous processing conditions soaking the corn grits for a particular period of time showed a enhanced product attributes, that will be less production cost as well as increases the consumption rate.

3.1 Particle size distribution
The cooked corn grits are sieve analyzed and observations are done on appearance, flavor absorption, color and cooking time. The different corn grit sizes showed variations and are stated in the table no.1.

Table 1: Cooked grits sieve analysis observation.

Sieve size (mm)	Appearance	Flavor Absorption	Color	Cooking time (mins.)
0	Very poor, Fines	No	Fines	Nil
3.5	Poor, Broken	Very less	Very pale	15
4.0	Rugged	Medium	Pale	19
4.75	Good	Good	Yellowish Orange	22
5.6	Perfect shape & Size	Very good	Yellowish Orange	28
6.5	Larger	Good	Dark	36

5.6 mm grits, are found to be perfect in shape, size, color and also showed better absorption rate, reduced cooking cycle time. Hence, the 5.6mm grit size also diminishes the oil content, Long chain proteins also gets broken lowered to less than 6.5%, which will be very helpful for digestion.

3.2 Moisture content determination and tempering
The Moisture analysis for the cooked corn grits are done as per the below mentioned parameters in table no.2.

Table 2: Moisture analysis.

Sample	Corn grit
Temperature (˚c)	135
Time (hrs.)	2
Initial Moisture (%)	3.2
Final Moisture (%)	33.6

Table 3: Tempering parameter standards.

Parameters	Test sample 1	Test sample 2
Grits (g)	300	250
Water (ml)	600	500
Grits: Water ratio	1:2	1:2
Soak time (mins.)	40	30
Soak temperature (˚c)	32	32

Soaking showed good results in removal of flour at maximum level. Dumping grits in water for certain time, lowers the fiber strands thereby helps in less cooking time. And hence this is most recommended for improvising the product quality of corn puff.

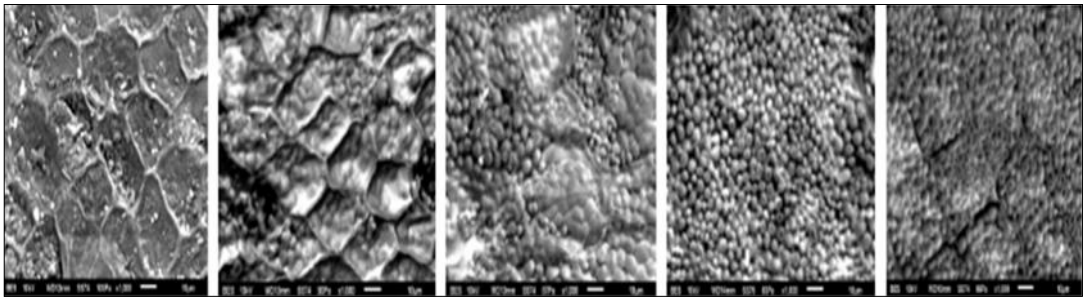
3.3 Analytical tests
The soaked sample generated the starch content wherein reverse reduces gradually the crude protein. As the crude protein get lowered the oil content is diminished so that the corn puff will be free from stickiness and enlarges in shape and gives the desired product. And the analytical test values are mentioned in table no.4.

Table 4: Nutritional analysis.

Starch content	86.5% dry basis
Crude protein	6.1%
Oil	0.6%
Neutral Detergent Fiber (NDF)	0.9% (dry basis)

3.4 Morphological observation of corn grits

The SEM (Scanning Electron Microscope) clearly defines that on soaking the corn grits for a periodic time, the corn grit pericarp loosens and changes are that hard corn grit raw material is polygonal shape and closely arranged, while soaked corn grit is spherical shape and loosely arranged inside protein matrix.



A B C D E

Fig 1: The Observation by SEM (A) (B) Raw corn grit (C) (D) (E) Soaked corn grit.

The initial raw material has a hard layered which is indicated in the first two images and the following three images shows on SEM analysis that the soaked corn grits is soft layered and small in matrix. Hence, this lowers the cooking time and proved the good flavor and color of corn puff.

3.5 Texture analysis

One of the most important quality parameters of the flake products is the time during which, when soaked in milk, their texture is still acceptable for consumers. The texture of the food depends on its underlying microstructure and its corresponding mechanical properties. The textural characteristics (hardness, work of compression, crispiness and crunchiness) of the flake product with the added dry residue from wild oregano are presented in Table no.5.

Table 5: Texture attributes of corn puff

Textural parameters	Old sample	Cooked sample	Soaked sample
Hardness /g	15510 ± 2^{b}	14350 ± 3^{b}	8880 ± 4^{a}
Work of compression /g s^{-1}	8270 ± 2^{b}	7790 ± 2^{b}	4940 ± 2^{a}
Crispiness	20.20 ± 1.92^{ab}	17.80 ± 5.17^{a}	23.60 ± 2.07^{b}
Crunchiness /g s^{-1}	59338 ± 27368^{a}	59369 ± 10327^{a}	62094 ± 2771^{a}

4. Conclusion

In this study, the two methods of soaking and size distribution of corn grits has been suggested as methods of solution for the problem low flavor absorption and long cooking cycle time. On the methods different characteristic attributes are analyzed and standardized. Based on the analysis, it is better to manufacture the corn puff after soaking the corn grits for certain periodic time so that it improvises the product quality as well as enhances the nutritional value also. Grit hardness reduction is due to protein matrix degradation that packs starch granular of horny endosperm. Particle size distribution measurement on corn grit after cooking verifies that grit hardness difference affect absolutely to corn grit particle size. To fulfill 90% of the problem the corn grits size of 5.6 is recommended as it gives the perfect shape and size, excellent flavor absorption in yellowish orange color with cooking cycle of 28mins. Or soaking the grits for 30mins. This parameters varies according to climate and surrounding temperature.

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