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Puffing mechanism and physical evaluation of cowpea

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Abstract
Puffing of cowpea involves heating in hot sand for a short time resulting in a puffed type of healthy snack food. The aim of the present study was to understand the puffing ability of cowpea. Calculations for puffing yield, expansion volume and bulk density from the samples. This was necessary because their puffing yields were generally relative to more established puffed products. It was identified as a superior puffing treatment of salt treated T_3 (19% puffed yield and 1.1 ml/g expansion volume) in a concentration of 4% salt with soaking and conditioning time 30:300min, while baking soda treated S_2 had greatest expansion volume (1.12 ml/g) and puffing yield (20%) in the concentration of baking soda 2% with soaking and conditioning (5:30min). cowpea was found to have a puffing performance, which suggests that potential exists within the genetic pool to improve both the puffing yield and the expansion volume of seeds for this snack food market.

Keywords: Puffing mechanism, physical evaluation, cowpea, snack food market

1. Introduction
Cowpea (*Vigna unguiculata /Vigna sinensis*) also known as Southern pea, China pea, Black-eye bean or Cow gram in the United States is an edible legume belonging to the family *Fabaceae*. The crop was first introduced to India during the Neolithic period, and therefore India seems to be a secondary centre of genetic diversity (Hamid *et al*., 2014) [3].

It is one of the most widely used legume and important proteinaceous pulse crop largely grown in Maharashtra as well as in various states of India. Cowpea is also an important pulse and legume crop cultivated in India. Area under cowpea cultivation in India is 3.9 million hectares with a production of 2.21 million tons with the national productivity of 683 kg per hectare (Yadav *et al*., 2015) [15].

Cowpea due to its nutritional benefits has also gained industrial importance for being used as a potential ingredient in different food formulations. The knowledge of dimensions is very useful in determining dehulling and would also help in designing the grader, cleaner and separator for the seeds (Tchiagam *et al.*, 2011) [11].

Cowpea is rich in lysine and makes good complementary food with legumes, which is rich in sulfur-containing amino acids such as methionine. (Timco and Singh, 2008).

The nutritional content of cowpea varies mainly because of genetic background as well as climate change, fertilizer, season and agronomic practices (Kochhar *et al.*, 1988). Despite of all such nutritional attributes, like other legume seeds, cowpea also contains certain antinutritional factors (ANFs) like phytic acid, trypsin inhibitor, haemagglutinin, hydrogen cyanide, galactosides, saponin, oligosaccharides such as raffinose, stachyose, verbascose and phenolic compounds (Owolabi *et al.*, 2012; Udensi *et al.*, 2007)[8, 14]. These antinutrients form complexes with minerals and protein, rendering them less soluble or less susceptible to enzymatic degradation and less available for absorption in body (Towo *et al.* 2003) [13]. The puffing significantly increased the availability of net protein utilization from 65 to 74 % and Net Dietary Protein Energy from 8.6 to 9.5%. Heat treatments of pulses are used to remove antinutritional factors (Yadav *et al.*, 2015) [15].

Some health benefits of cowpea include toning the spleen, stomach and pancreas. In addition to dietary fiber, cowpea contains many health-promoting components such as vitamins, minerals and phytochemicals, which include phenol compounds which are antioxidants with ability to prevent degenerative diseases (heart diseases and cancer) (Imrie and Hyde, 2004) [5].

Puffing imparts acceptable taste and desirable aroma to the snacks. There are different methods of puffing used viz., conventional method of dry heat, sand and baking soda treated, hot air puffing, gun puffing, puffing in hot oil and by microwave heating. Though a wide range of cowpeas and millets such as rice, wheat, corn, sorghum, ragi, foxtail millet are used for puffing; only few of them puff well. The reason behind this may be the factors which influence puffing qualities of cowpeas, such as season, varietal difference, cowpea characteristics such

as moisture content, composition of cowpea, physical characteristics, types of endosperm, and also the method of puffing. Therefore, this research aimed at providing brief review of puffing characteristics of different treatments on cowpea and puffing methods in response to high puffing yield and greater volume expansion volume elevated by Gayatri *et al.*, (2014) [2].

Materials and Methods

Materials

Cowpea samples were procured from the local market and verities used were Pusa phalguni and Pusa barsati.

Method

Physical properties of raw cowpea seeds

Seed physical properties like Length (mm), Breadth (mm), Thickness (mm), Length breadth ratio, 1000 kernel weight (g), Bulk Density (g/ml), True Density (g/ml), Porosity (%), Angle of repose, Hardness (kg) were determined as per the these methods are prescribed by Henshaw, (2008) [4].

Soaking and Conditioning

Soaking and conditioning were carried out with the salt treatments (T_0-0:0min, T_1-1:15 min and 2% salt, T_2- 5:30min and 3% salt, T_3: 30:300 min and 4% salt, T_4-60:600min and 5% salt). While in baking soda treatments (S_0- 0:0min, S_1-1 and 2% baking soda, S_2-5:30 min and 3% baking soda, S_3-30:300 min and 4% baking soda, S_4- 60:600min and 5% baking soda).

Puffing process

The cowpea puffing was carried out with procedure of Chinnaswamy and Bhattacharya, (1983) [1] studied that puffing is cooking in sand puffing method, exposed to hot sand, while temperature of sand is about 250°C. Due to sudden thermal gradient, the moisture inside the cowpeas vaporizes and tries to escape through the micropores, expanding the starchy endosperm in size in this process.

Physical properties of puffed cowpea

As there were no clear criteria in the literature for distinguishing between puffed and unpuffed cowpea, the following criteria were developed in this study to identify each successfully puffed seed within the sample: a puffed seed had a cracked or missing outer husk, with visible golden-yellow colored cotyledon and an expanded volume.

Expansion volume: of raw and puffed cowpea was determined by determining the total volume of puffed cowpea to the total volume of cowpea (Maskus and Arntfield, 2015) [7].

$$\text{Expamsion volume} = \frac{\text{Total puffed volume of cowpea}}{\text{Original volume of cowpea}}$$

Puffing Yield (%): of raw and puffed cowpea was determined by (Singh & Srivastava, 1993).

$$\text{Puffing Yiekd (\%)} = \frac{\text{Weigh of puffed cowpea}}{\text{Weight of puffed and unpuffed cowpea}}$$

3.5.3 Bulk Density

Volume of 100 g puffed cowpea was recorded and the bulk density was expressed as g/ml (Maskus and Arntfield, 2015) [7].

Table 1: Physical properties of the puffed cowpea

Treatments	Physical properties		
	Expansion volume (ml/g)	Puffing Yield (%)	Bulk density (g/cm^3)
T_0	1.01	12	1.8
T_1	1.03	14	1.6
T_2	1.02	17	1.3
T_3	1.10	19	1.1
T_4	1.08	18	1.0
SE±	0.007	0.400	0.048
CD at 5%	0.027	1.204	0.145

Note: Each value is a mean of three determinations.

The expansion volume of puffed cowpea was highest for treatment T_3 i.e. 1.10ml/g as the concentration of salt 4% with soaking and conditioning time (30:300min), puffing yield 19%, and bulk density 1.1g/cm^3 of treatment T_0 as the concentration of 0% salt i.e. without soaking and conditioning of puffed products studied by Soumi *et al*., (2015) [10] on the evaluation on puffing quality of Australian chickpeas.

Table 2: Physical properties of the puffed cowpea

Treatment	Physical properties		
	Expansion volume (ml/g)	Puffing Yield (%)	Bulk density (g/cm^3)
S_0	1.08	13	1.8
S_1	1.09	16	1.7
S_2	1.12	20	1.5
S_3	1.11	17	1.2
S_4	1.10	18	1.1
SE±	0.005	0.490	0.047
CD at 5%	0.014	1.457	0.139

Note: Each value is a mean of three determinations.

The highest expansion volume of the baking soda treated S_2 is 1.12ml/g, puffing yield 20% and bulk density 1.5g/cm^3 as the concentration of salt 2% with soaking and conditioning time (30:300min) followed by S_3 as the concentration of baking soda 3% with soaking and conditioning time (60:600min) of puffed products studied by Soumi *et al*., (2015) [10] on the evaluation on puffing quality of Australian chickpeas.

Conclusion

Performance of cowpea puffing considerably increasing in puffing yield and expansion volume while bulk density was decreasing as treatments increased. The expansion volume was identified as a superior puffing treatment of salt treated T_3 (19% puffed yield and 1.1 ml/g expansion volume) in a concentration of 4% salt with soaking and conditioning time 30:300min, while baking treated S_2 had greatest expansion volume (1.12 ml/g) and puffing yield (20%) in the concentration of 2% baking soda with soaking and conditioning (5:30min). This study has shown that there is potential to improve cowpea qualities for commercial puffing by the traditional Indian method.

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