



CORRELATION BETWEEN PROPERTIES OF PEARL MILLET AND COMMERCIAL CORN STARCH BASED ON PHYSICO-CHEMICAL AND FUNCTIONAL PROPERTIES

Agricultural Science

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ABSTRACT

Now a days, demand of cheap source of starch is focusing towards use of underutilized crops i.e., pearl millet. Corn and pearl millet are the important source of starch. The present study was conducted to correlate the characteristics of commercial corn and pearl millets starches. Both starches were evaluated for chemical composition, percent purity, and functional properties. It was observed that chemical composition and functional properties were significantly correlated to each other. Starch isolated from pearl millet by wet steeping method yielded 24% starch with less impurity. Pearl millet starch showed significantly higher percent purity, swelling power, water holding capacity than commercial corn starch. It can be concluded that pearl millet starch may be alternate of corn starch in developing various food products.

KEYWORDS:

Correlation, Pearl millet, Starch

INTRODUCTION

Starch is the major component of cereal grains and a common ingredient used in the food industry. Starches are mainly used in foods as an agent for thickening and gelling. Commercial native starches find applications in cosmetic dusting powder, laundry stiffening agent, paper and photographic paper powder, sugar coating in confectionary, and excipient for pharmaceutical tablets (Zobel and Kulp, 1996). Starch properties depend on the physical and chemical characteristics such as mean granule size distribution, amylose/amylopectin ratio (Blazek and Copeland, 2008).

Pearl millet is a lesser known and underutilized crop. It is relatively a cheaper source of nutrients and staple food for populations below poverty line for economic reasons. Pearl millet is highly palatable and a good source of protein, minerals and energy (Siroha et al., 2016). Pearl millet being an underutilized poor man's food crop can be a cheap alternative source of starch. Limited studies have been carried out on pearl millet starch as compared to other cereal and tuber crops

(Freeman and Bocan, 1973; Abdalla et al., 2009). The advent of using starch in value-added applications however provides an opportunity for industry to capitalize on the unique properties of the pearl millet starch, increases its demand and overcomes current price limitations. Keeping these facts related to pearl millet starch, present study was undertaken to examine the physicochemical and functional properties of starches from pearl millet and commercial corn and to establish correlation between various properties.

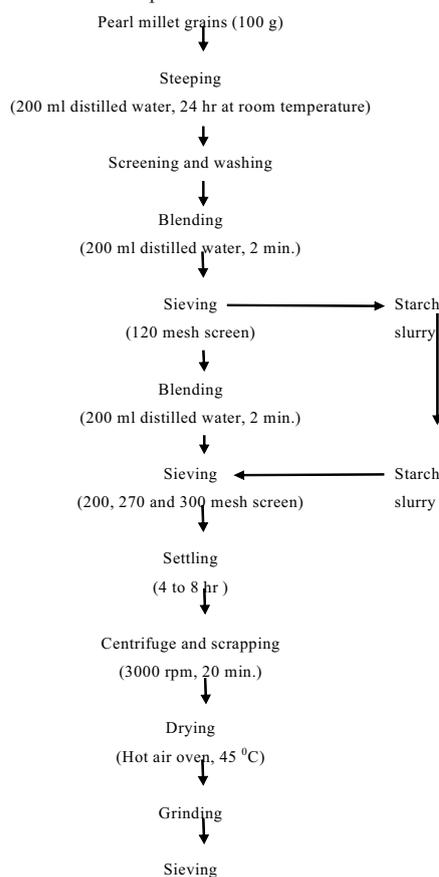
MATERIALS AND METHODS

Materials

Pearl millet variety was procured from CCS HAU, Hisar, India. Commercial corn starch was bought from Rockette, Mumbai, India.

Starch isolation

Starch was isolated from pearl millet variety by wet steeping method as shown (fig. 1).



Proximate composition

Starches were evaluated for moisture, crude protein, crude fat, crude fibre and ash content by the standard methods of AACC (2000).

Purity

Purity, expressed as a total starch percentage was calculated by using the method of Perez *et al.* (1997).

Purity (%) = 100 - (moisture + crude protein + crude fat + ash + crude fiber)

Yield

Yield (%) was calculated as per method described by Perez & Amaiz (2004).

$$\text{Starch yield (\%)} = \frac{\text{Weight of extracted starch}}{\text{Weight of pearl millet grains}} \times 100$$

Amylose and amylopectin content

Amylose content of the starch was determined by the described method by Williams *et al.* (1958)

Chemicals and Reagents

- (i) Stock Iodine solution: 20 g of potassium iodide along with 2 g iodine were mixed with distilled water and volume was made to 100 ml
- (ii) Iodine reagent: 10 ml of stock iodine solution was diluted to 100 ml with distilled water
- (iii) 0.5 N KOH: 28.05 g potassium hydroxide was mixed with distilled water to make total volume of 1 l
- (iv) 0.1 N HCl: 8.17 ml concentrated hydrochloric acid was mixed with distilled water to make total volume of 1 l

Procedure

The starch (20 mg) was mixed with 10 ml of 0.5 N KOH into a 100 ml beaker and stirred with magnetic stirrer for 5 min. The contents were transferred into 100 ml volumetric flask and volume was made to 100 ml with distilled water. Starch solution (10 ml) was transferred into 50 ml conical flask followed by addition of 5 ml of 0.1 N HCl and 0.5 ml iodine reagent respectively with constant shaking. The absorbance of this solution was measured at 625 nm. The amylose content was determined using the following suggested equation:

$$\text{Amylose content} = 85.24X - 13.19$$

Where,

X = Absorbance.

$$\text{Amylopectin content} = 100 - \text{Amylose content}$$

Water binding capacity (WBC)

Water binding capacity was determined using the method (Yamazaki 1953; Medcalf & Gilles 1965)

A suspension of 5 g starch (dry basis) in 75 ml distilled water was agitated for 1 hr and centrifuged at 3000 rpm for 10 min and excess water was drained for 10 min and then weighed.

$$\text{Water binding capacity (\%)} = \frac{W_{rs} \times 100}{W_s}$$

Where,

W_{rs} = weight of residual starch (g)

W_s = weight of sample (g)

Swelling power (SP) and Flour solubility (FS)

Swelling power and solubility were determined as per the method described by Qing-Bo *et al.* (2005).

Each sample (3.0 g) was dispersed in 30 ml of distilled water and stirred gently. The dispersion was allowed to stand for 30 min. in a water bath at 35 ± 5 °C. Subsequently, the dispersion was centrifuged at 3000 rpm for 15 min. The supernatants were decanted into an evaporating dish of known weight, dried at 110 °C and weighed. The swelling power and solubility were calculated using following equations:

$$\text{Swelling power (g/g)} = \frac{\text{Weight gain by gel}}{\text{Dry weight of sample}}$$

$$\text{Solubility (\%)} = \frac{\text{Weight of dry solids in supernatant} \times 100}{\text{Dry weight of sample}}$$

Gel consistency

Starch gel consistency was measured by the method of Yadav *et al.* (2006).

Starch samples (0.1 g, dry basis) were wetted in a test tube with 0.2 ml of 95% ethanol containing 0.025% bromothymol blue and dispersed in 2 ml of 0.2 N KOH. The tubes were heated in a vigorously boiling water bath for 8 min, cooled at room temperature for 5 min followed by cooling in an ice water bath for 20 min and then laid down horizontally for 1 hr at room temperature. Longer the gel travel within tube implies the lower consistency.

Results and Discussion**Chemical composition**

The chemical composition of commercial corn and pearl millet starches are summarized in Table 1. As shown from the table, yield of starch obtained from pearl millet grain was 24%. Commercial corn starch showed lower percent purity as compared to pearl millet starch (Table 1). Moisture content and protein content of commercial corn starch was higher than pearl millet starch, this may be due to improper packaging and storage of corn starch. Less residual protein in pearl millet starch indicated less impurity present in pearl millet starch. Fat, crude fibre and ash contents of commercial corn starch were lower than pearl millet starch as depicted in Table 1. Results of pearl millet starch were in accordance to results documented by Bhupendra *et al.*, 2014. Amylose and amylopectin compositions of commercial corn and pearl millet starches are also presented in Table 1. Amylose content of commercial corn and pearl millet starches were 17.2 and 16.2%, respectively. Variation in chemical composition of starches may be attributed to difference in source of starch, genetic make-up and method of isolation of starch. Purity and yield of starch determines the end use of starch and efficacy of starch isolation method.

Functional properties

The functional properties play an important role in the production of different types of products. Functional properties of commercial corn and pearl millet starches are depicted in Table 2.

Swelling power, flour solubility, and water holding capacity of pearl millet starch was higher than of commercial corn starch as shown in Table 2. SP and FS of pearl millet starch was found to be 1.80g/g and 1.22%, the result was in accordance to results obtained by Bhupendra *et al.*, 2013; Suma and Urooj, 2015. Swelling power indicates the ability of starch to hydrate under specific cooking conditions and solubility of starch is an indicator of the degree of starch granules dispersion after cooking and could imply to the amount of amylose leaching out from starch granule (Singh *et al.*, 2006). Variation in these properties of starch may be associated to amylose content, structure of amylopectin and presence of non-carbohydrate substances i.e., lipid and protein acting as inhibitor of swelling (Tester and Morrison, 1990, Sasaki & Matsuki, 1998).

Gel consistency of pear millet starch was lower than commercial corn starch (Table 2).

Pearson's correlation coefficient between commercial corn and pearl millet starches

Pearson's correlation coefficient between commercial corn and pearl millet starches for various properties is shown in Table 3. Moisture content had significant positive correlation with other parameters. Fat content was positively ($P < 0.05$) correlated with crude fibre, amylose content, swelling power and water holding capacity, however significant negative correlated with protein content. All parameters had significant correlation with each other.

Conclusion

Significant difference for chemical composition and functional properties was observed between commercial corn and pearl millet starches. Significant positive correlation was existed between chemical composition and functional properties. It was noticed higher percent purity of pearl millet starch which exhibited significant difference in functional properties with commercial corn starch. One can say that pearl millet starch could be used instead of corn starch in processing of various food products, which may have futuristic marketing potential in recent years.

Table 1: Chemical composition of starch

Parameters (%)	Commercial corn	Pearl millet
Yield	NA	24±0.40
Purity	84±1.03	87.96±0.15
Moisture content	13.48±0.24	8.39±0.37
Fat	0.002±0.00	1.1±0.31
Protein	1.78±0.77	1.03±0.08
Ash	0.5±0.04	0.86±0.03
Crude Fibre	0.25±0.04	0.73±0.03
Amylose content	17.2±0.20	16.2±0.26
Amylopectin content	82.8±0.20	83.8±0.26

*Values are means±SD of 3 replications.

Table 2: Functional properties of starch

Parameters	Commercial corn	Pearl millet
Swelling power	1.67±0.03	1.80±0.02
Flour solubility	0.20±0.12	1.22±0.11
Water binding capacity	172±1.45	1.90±1.63
Gel consistency	104±0.45	97.3±0.06

*Values are means±SD of 3 replications.

Table 3: Pearson's correlation coefficient between chemical composition and functional properties

	MOISTURE	FAT	PROTEIN	CRUDE FIBRE	ASH	AMYLOSE	SP	FS	WHC
MOISTURE	1.00								
FAT	0.78	1							
PROTEIN	0.84	-0.13	1						
CRUDE FIBRE	0.79	0.54	0.87	1					
ASH	0.89	0.4	0.24	0.73	1.00				
AMYLOSE	0.77	0.78	0.77	0.77	0.77	1.00			
SP	0.78	0.77	0.68	0.75	0.78	0.78	1.00		
FS	0.77	0.44	0.71	0.61	0.62	0.78	0.71	1.00	
WHC	0.77	0.77	0.77	0.77	0.67	0.66	0.67	0.67	1

*SP=Swelling power; FS=Flour solubility; WHC= Water holding capacity

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