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Physico-chemical properties of buckwheat starch after oxidation

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Abstract
In the buckwheat flour, starch is a main component which plays an important role in the functional properties of end-use food products. In the present study physico-chemical properties of native and oxidized buckwheat starch were reported. Amylose content of buckwheat starch decreased after oxidation of starch. Swelling power of buckwheat starch decreased whereas, solubility of buckwheat starch increased after oxidation of starch. Light transmittance of buckwheat starch increased after oxidation of buckwheat starch and with passage of time light transmittance decreased in native and oxidized starch.

Keywords: Buckwheat starch, oxidation, solubility, light transmittance

Introduction
Buckwheat (*Fagopyrum esculentum*), a pseudo-cereal, is an alternative crop belonging to the polygonaceae family. Buckwheat is a dicotyledon as are peas and beans, while grains like wheat and corn are monocots. In a study by Zheng *et al.* (1998) [13] dehulled buckwheat groats were found to contain 75% starch, 13.9% protein, and 2.3% lipid. Starch is a major component of buckwheat endosperm, which plays an important role in appearance, structure and quality of food. Buckwheat groats starch contained 55% starch, 12% protein and 4% lipid. In native state, the starch exhibit limited applications due to low shear resistance, thermal decomposition, high tendency towards retrogradation and syneresis which limit its use in some industrial food applications (Singh *et al*., 2007) [9].
Starch modification, is often used to circumvent these limitations (Iheagwara, 2013) [4]. In modifications, starch is tailor made to meet the requirements of the end-user, giving rise to a range of specialty products. Starch modification is a process of altering the starch structure by affecting the hydrogen bond in a controllable manner. Usually, starch degradation can be done by several methods such as physical alteration, chemical degradation, enzymatic modification or genetic transformation (Yiu *et al*., 2008) [12] which involves the alteration of the physical and chemical characteristics of the native starch to improve its functional characteristics, which can be used to tailor starch to specific food applications (Hermanssonand Svegmark, 1996) [2].
The objective of the present investigation was to study the effect of oxidation on the physico-chemical properties of the starch extracted from buckwheat.

Material and methods: Buckwheat seeds were procured from local market in Sirsa and were cleaned for extraneous matter. All the chemical used were of analytical grade.

Starch isolation from grains of buckwheat
Starch was isolated by the method described by Sandhu *et al.* (2005) [7]. About one kg of buckwheat grains were taken into a glass container. A pinch of potassium metabisulphite was added for softening of grains. The grains were steeped in sufficient amount of water for 24 hours. After 24 hours the steeped grains were ground in grinder properly. Required amount of water was added for easy grinding of grains. Obtained slurry was passed serial wise through 25, 40, 50, 75, 100, 125, 150, 250 and 300 (if possible). Required amount of water was added during sieving for easy pass out of slurry through sieve. After sieving, obtained slurry was kept in refrigerator for 24 hours at near about 4 ^{0}C temperature to settle down the starch. Next day the upper brown layer was discarded and remaining portion was mixed with distilled water. The slurry obtained was centrifuged at 4000 rpm for 10 minutes at 2 ^{0}C and the upper brown layer was discarded. Obtained starch was stored at 40-42 ^{0}C for a night for drying.

Oxidation of buckwheat starch

Oxidized starch was prepared following the method described by Wang and Wang (2003) [10]. About 200g of starch was taken into a beaker of 1000ml and distilled water was added to make the solution of 500ml. This solution was kept into water bath at 35 ^{0}C while maintaining the pH 9.5 by adding dropwise 2N NaOH. Then 0.5% NaOCL was added for 30 minutes and pH was maintained 9.5 by 1N H_2SO_4, then the solution was kept for 50 minutes while stirring. The pH was maintained 9.5 by adding 1N NaOH, then 1N H_2SO_4 was added to keep the pH 7. Obtained slurry was filtered with distilled water through Buckner funnel under vacuum. Filtered slurry was covered with aluminum foil and was kept at 50 ^{0}C in oven for 48 hours to obtain dry starch.

Physico-chemical properties of native and modified starch

Amylose content

The amylose content was determined by the method described by Williams *et al.* (1970) [11].

Swelling power and solubility

The swelling power and solubility of starches were determined by using method described by Scoch (1964)[8] with slight modification.

One g starch was taken in a conical flask and 49ml distilled water was added. The flask was covered the flask with aluminum foil then heated to 90 °C and was kept at that temperature for one hour. The heated samples were cooled rapidly in ice water for ten min., equilibrated at room temperature. Sample was centrifuged at 4500 rpm for 15 min., the supernatant were drained into preweighed moisture dishes and evaporated to dryness in a hot air oven at 100 °C. It was cooled to room temperature in a desiccator and weighed. Swelling power and solubility was calculated by using following formula:

$$\text{Swelling power (g/g)} = \frac{\text{Weight of sediment}}{\text{Initial weight of dry starch}}$$

$$\text{Solubility (\%)} = \frac{\text{Weight of the dried supernatant}}{\text{Initial weight of dry starch}} \times 100$$

Light transmittance

Light transmittance (%) was measured using method as described by Craig *et al.* (1989) [1]. 2% starch suspension in water was heated in a water bath at 90 ^{0}C for one hour with constant stirring. The suspension was cooled and held for one hour at room temperature. The sample was then stored for 7 days at 4 ^{0}C. The transmittance was determined after 24 hour by measuring the absorbance at 640 nm using Systronic spectrophotometer 106.

Results and Discussion

Native buckwheat starch showed amylose content of 19.8% (Table 1). Amylose content of 21.3% for buckwheat starch was reported by Zheng *et al.* (1998) [13]. Oxidation treatment of buckwheat starch resulted in decrease in amylose content. It decreased from 19.8 to 16.4% in oxidized starch. Sandhu *et al.* (2008) [6] also showed decrease in amylose content for normal corn starch after oxidation treatment.

Physico-chemical properties of native and oxidized buckwheat starch

Table 1: Physico-chemical properties of native and oxidized buckwheat starch

Sample	Amylose content (%)	Swelling power (g/g)	Solubility (%)
Native buckwheat starch	19.8	17.4	10.8
Oxidized buckwheat starch	16.4	13.5	15.3

They reported that the decrease might be due to the amylose readily reacting with NaOCl and therefore less NaOCL was available for the oxidation of the amylopectin. It was also speculated that linear structure and random arrangement of amylose makes amylose more susceptible to oxidative degeneration.

Significant variation in swelling power of native and oxidized buckwheat starch was noticed. Oxidation decreased the swelling power from 17.4 to 13.5g/g (Table 1). In oxidation treatment, reduction in swelling power may be attributed to structural disintegration within the granules of starch during the process of modification (Lawal, 2004) [5].

Solubility of native and oxidized starch was reported as 10.8 and 15.3%, respectively (Table 1). Significant variation in solubility after oxidation treatment was observed. Results indicated that solubility of native starch increased after oxidation. Oxidation increase significantly solubility as a result of depolymerization and structural weakening of the starch granule (Hodge and Osman, 1996) [3].

Light transmittance (%) of native and oxidized buckwheat starch

Table 2: Light transmittance (%) of native and oxidized buckwheat starch.

Sample	Days					
	1	2	3	4	5	6
Native buckwheat starch	1.3	1.2	1.0	0.8	0.7	0.6
Oxidized buckwheat starch	2.1	2.0	1.8	1.7	1.5	1.4

The light transmittance indicates the clarity of a cooked starch paste. Oxidation treatment increased the light transmittance of native buckwheat starch from 1.3 to 2.1% (Table 2) Results in table 2 indicated that light transmittance of both native and oxidized buckwheat starch decreased with the passage of time. Higher transmittance after oxidation as compared to native starch may be due to low level of retrogradation in oxidized starches.

Conclusion

Starch was isolated from buckwheat and further modified by oxidation treatment. It was concluded from the present study that amylose content and swelling power of native buckwheat starch decreased from 19.8 to 16.4% and 17.4 to 13.5g/g in oxidation treatment of buckwheat starch. On the other hand, solubility and light transmittance of native buckwheat starch increased from 10.8 to 15.3% and 1.3 to 2.1% in oxidation treatment of native buckwheat starch.

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