# Composition, Physicochemical and Morphological Characterization of Pumpkin Flour

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## ABSTRACT

Pumpkin provides a valuable source of carotenoids and ascorbic acid which have major roles in nutrition as provitamin A and as an antioxidant respectively. Pumpkin can be processed into flour which has a longer shelf-life. Pumpkin flour was prepared by hot air-drying of pumpkin (*Cucurbitaceae moschata Decne*) pulp. The objectives of this research were to determine the physico-chemical properties of pumpkin flour. Pumpkin flour exhibited high levels of carbohydrate (79.57 %), starch (48.30 %), dietary fiber (12.1%) protein (7.81%) and total ash (5.29 %); low contents of lipid (3.60%) and crude fiber (3.65 %). Vitamin A was 48.30 µg/100g. Pumpkin flour peak gelatinization temperature was 75.3°C, the water solubility index WSI was 27.58% and the water absorption index WAI was 491.75%. The pasting properties were: temperature: 45.5°C; peak viscosity: 87.55 RVU; breakdown: 3.22 RVU; setback: 56.58 RVU and trough: 84.33 RVU. The morphology of the starch granules, observed by scanning electron microscopy, had less smooth granule surfaces and appeared as a mixture of spherical, polyhedral and irregular shaped with sizes ranging from 5 to 15 µm. The overall results are suggestive of the potential of pumpkin as a source of flour and may find suitable applications in the food processing industry for novel product development.

*Keywords: pumpkin; flour; starch; composite flour; physical properties; morphology*

## INTRODUCTION

Pumpkin is from genus *Cucurbita* of the family Cucurbitaceae. It includes squash and cucumbers which are grown throughout the tropical and sub tropical countries. There are three common types of pumpkin world-wide, namely *Curcurbita pepo*, *Curcurbita maxima* and *C. moschata* [1]. Pumpkin can be found in many shapes, sizes and colours. Agriculture, food-processing, pharmaceutical as well as feed industry have all taken growing interest in pumpkin fruit and pumpkin-derived products in the past few years because of the nutritional and health protective value of the proteins and oil from the seeds as well as the polysaccharides from the fruit [2]. Pumpkin is a good source of carotene, pectin, mineral salts, vitamins and other substances that are beneficial to health [3]. These facts lead to the processing of pumpkin into various food products. It has been used to supplement cereal flours in bakery products, soups, sauces, instant noodle, spice as well as a natural colouring agent in pasta and flour mixes. They are rich in carotene, pectin, mineral salts, vitamins and other substances beneficial to health [4]. The composition of fresh pumpkin and pumpkin flour is shown in Table 1 [5]. In this investigation, pumpkin pulps were processed into flour, the composition of pumpkin was studied and neither physicochemical nor morphological analysis was carried out.

**Table 1:** Proximate composition of fresh pumpkin and pumpkin flour.

| Composition (%) | Fresh Pumpkin | Pumpkin Flour |
|---|---|---|
| Moisture | 92.24 | 10.96 |
| Fat | 0.15 | 0.80 |
| Protein | 0.98 | 9.65 |
| Ash | 0.76 | 5.37 |
| Crude fiber | 0.56 | 0.81 |
| Carbohydrate | 5.31 | 72.41 |

## MATERIALS & METHODS

### *Plant materials*

Commercial pumpkin (*Cucurbitaceae moschata Decne*), a green-yellow cultivar grown in Thailand, were purchased from the local market in Bangkok, Thailand. The fresh pumpkins were cleaned, peeled, cleaned of seeds, sliced into pieces 1 cm thick, and then washed in cold water and immediately soaked in $K_2S_2O_5$ solution (1% w/v) for 10 min. The slices were dried at 65 °C in a hot-air dryer (Memmert 854 Schwabach, Germany), ground using a commercial grinder and pass a sieve (60 mesh) and stored at 25 °C in sealed plastic containers prior to further analyses.

### *Compositions*

Moisture, crude protein, fat, ash, starch and dietary fiber were determined in triplicate by standard procedures AOAC [6]. Carbohydrate content was calculated as difference.

### *Physico-chemical characteristics and starch morphological*

Water solubility index (WSI) and water absorption index (WAI) were determined [7]. Physicochemical properties, using the Rapid Visco Analyzer (RVA, super3, Australia). Starch pasting profiles were obtained with a Rapid Visco Analyser (RVA, Newport Scientific, Warriewood, Australia). Flour samples (3.0 g dry basis) were dispersed in 25 g of distilled and deionized water. The temperature profile started with holding for 1 min at 50°C, followed by heating to 95°C over 4 min, holding at 95°C for 2 min and cooling to 50°C over 4 min. All measurements were performed in triplicate.

### *Morphology*

Scanning electron micrographs of the starches were obtained at different magnifications. Dry powdered starch was sprinkled on to double-sided sticky tape fixed on an aluminium stub, and coated with gold.

### *Statistical Analysis*

All the experiments were conducted in triplicate and the means ± standard deviation of three values are reported.

## RESULTS & DISCUSSION

### *Compositions of pumpkin powder*

The results of the chemical analyses performed on pumpkin flour are summarized in Table 2. Pumpkin flour exhibited high levels of carbohydrate (79.57 %), starch (48.30 %), dietary fiber (12.1%) protein (7.81%) and total ash (5.29 %); low contents of lipid (3.60%) and crude fiber (3.65 %). Vitamin A was 48.30 μg/100g. According to a study of some researchers [8, 5], protein content of pumpkin powder was reported to be 9%, respectively 9.65%. Further a composition of pumpkin powder was reported by Zhang and Guo [9] with 4.09 g fat, 21.06 g fiber and 301.57 mg calcium. Ptitchkina et. al [8] analysed pumpkin powder with a content of 40% cellulose, 4.3% hemi cellulose and 4.3% lignin, which are the main components of insoluble dietary fiber. It is an ideal food of diabetes patients, cardiovascular disease patients and old man.

**Table 2** Proximate composition, water solubility and water absorption index of pumpkin flour.

| Parameter | Mean ± standard deviation [a] |
|---|---|
| Moisture content (%) | 3.73 ± 0.01 |
| Fat (%) | 3.60 ± 0.12 |
| Crude fiber (%) | 3.65 ± 0.14 |
| Protein (%) | 7.81 ± 0.18 |
| Ash (%) | 5.29 ± 0.01 |
| Carbohydrate (%) | 79.57 ± 0.01 |
| Dietary fiber (g/100g) | 12.1 ± 0.00 |
| Starch (%) | 48.30 ± 0.54 |
| Vitamin A (μg/100 g) | 262 ± 0.32 |
| Water solubility index (%) | 27.58 ±1.13 |
| Water absorption index (%) | 491.75 ± 26.75 |

The values are the means of three determinations ± standard deviation.

### *Water solubility index (WAI) and water absorption index (WSI)*

Functional properties are the intrinsic physicochemical characteristics which may affect the behavior of food systems during processing and storage. The water solubility index was 27.58% and the water absorption index was 491.75% as shown in Table 2. Raw fluted pumpkin *(Tel/airiu occidentulis* Hook) flour had a higher water absorption capacity (12.1 g/g protein) than raw soya flour (4.5 g/g protein) [10]. The WAI of flour therefore gave an advantage of being used as a thickener in liquid and semi-liquids foods since the flours were able to absorb water and swell for improved consistency in food.

### *Physico-chemical characteristics*

In terms of food applications, the functionality of starch is largely related to its gelatinization and pasting characteristics. Starch, when heated in the presence of excess water, undergoes a phase transition from order to disorder known as gelatinization over a temperature range characteristic of the starch source. This phase transition is associated with diffusion of water into the granule, water uptake by the amorphous background region, hydration and radial swelling of the starch granules, loss of birefringence, loss of crystalline order, uptake of heat, uncoiling and dissociation of double helices in the crystalline regions and amylose leaching [11] as the results are listed in Table 3.

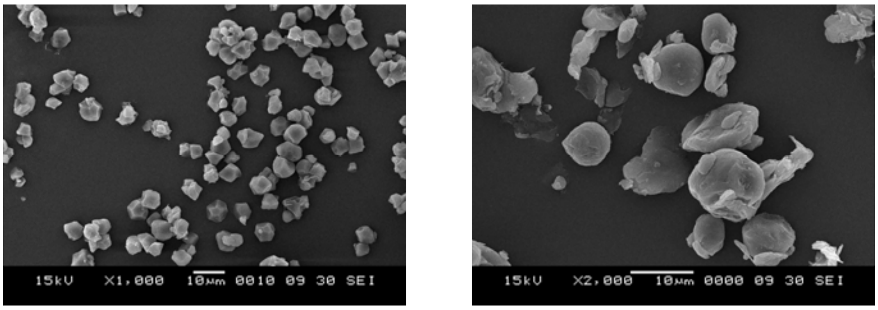
**Table 3** Pasting temperature of pumpkin flour.

| Parameter | Mean ± standard deviation [a] |
|---|---|
| Pasting Temperature (°C) | 45.50 ± 1.02 |
| Peak viscosity (RVU) | 87.55 ± 9.47 |
| Peak time (min) | 6.96 ± 0.08 |
| Peak temperature (°C) | 75.33 ± 2.08 |
| Trough (RVU) | 84.33 ± 9.79 |
| Break down (RVU) | 3.22 ± 0.42 |
| Final viscosity (RVU) | 140.92 ± 13.47 |
| Setback (RVU) | 56.58 ± 3.71 |

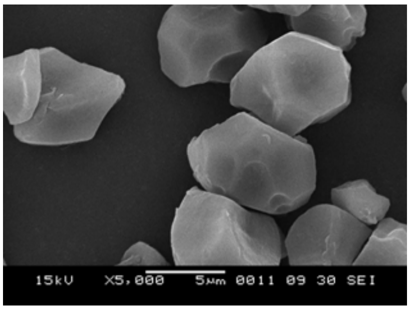
The values are the means of three determinations ± standard deviation.

### *Scanning Electron Microscopy*

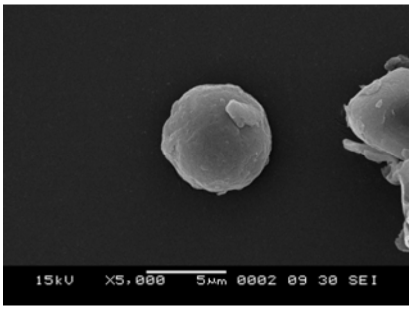
The granule size distribution of starches from different botanical sources has been reported to change during the development of the storage organs of plants [12]. The morphology of the full granule size distribution of the isolated pumpkin starch, observed by scanning electron microscopy, is shown in Figure 1. A mixture of spherical, polyhedral and irregular shaped with sizes ranging from 5 to 15 μm with less smooth granule surfaces can be observed.



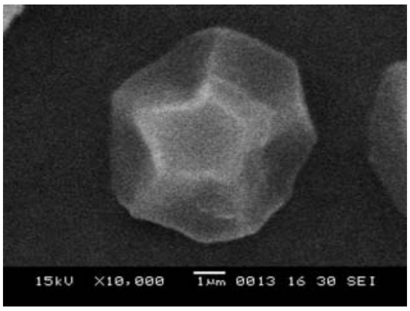

**(a) 1,000x** **(b) 2,000x**




**(c) 5,000x**




**(d) 5,000x**




**(e) 10,000 x**

**Figure 1.** Scanning electron micrographs of pumpkin starch granules at different magnifications.

## CONCLUSION

These investigations showed that pumpkin flour consist mainly of carbohydrate, is rich in dietary fiber and has small or medium size starch granules. Based on the observed composition and functionality, the pumpkin flour may find suitable applications in the food processing industry for novel product development. It can be used as a thickener in soup, gravy, fabricated snacks and as an ingredient in bakery products such as sandwich bread, sweet bread, butter cake, chiffon cake and instant fried noodles.

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