International Journal of Advanced Chemistry Research

ISSN Print: 2664-6781
ISSN Online: 2664-679X
Impact Factor: RJIF 5.32
IJACR 2022; 4(2): 41-46
www.chemistryjournals.net
Received: 15-07-2022
Accepted: 14-08-2022

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Effect of pretreatments and temperature on chemical properties of sweet potato flour

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DOI: https://doi.org/10.33545/26646781.2022.v4.i2a.75

Abstract
In this study slices of sweet potato were pretreated with different pretreatments such as; 0.1% w/v potassium metabisulfite (KMS), 1% w/v calcium chloride ($CaCl_2$) and blanching at 80 °C for 5 min. Pretreated sweet potato slices were dried in a mechanical tray dryer at 50, 55, 60 and 65 °C simultaneously at constant drying air velocity of 2 m/s in drying chamber. The dried samples were cooled at normal room temperature and grind. After grinding the chemical properties like protein, starch, total sugar, total soluble solids, ash, fiber and colour were studied. Protein temperature. Starch content was found maximum for KMS pretreated sample and decreases with increase in drying content was found maximum for control sample at 60 °C followed by $CaCl_2$, KMS and hot water blanching. Total sugar content was found maximum for $CaCl_2$ pretreated sample at 60 °C. Total soluble solids (TSS) was found increases with increase in drying temperature and found maximum for $CaCl_2$ pretreated sample at 65 °C, Ash content was found maximum for $CaCl_2$ pretreated sample and decreases with increase in drying temperature. Fiber content was ranged from 0.10 to 0.18 per cent.

Keywords: Sweet potato, pretreatments, tray DRYING, protein, starch, total sugar, total soluble solids, ash, fiber and colour

1. Introduction

Sweet potato is oldest fiber crop grown almost all over the world. It ranks as fifth important food crop in developing countries. (Zhang *et al*., 2000) [1] The total area and production of sweet potato in India is 1,34,900 ha and 16,38,800 MT in 2016-17 respectively and in Rajasthan state area and production of sweet potato is 1100 ha and 10910 MT in 2016-17 respectively. (Anonymous, 2017) [2]. The dry matter in sweet potato consists of average 70% starch, 10% total sugars, 10% total fiber, 5% total protein, 3% ash, 1% lipid and rest 1% vitamins, organic acids (e.g. folic acid and pantothenic acid) and other components. (Sablani and Mujumdar, 2006) [3]

Pretreatment is an important step before processing of food materials. It has been studied that pretreatment can not only accelerate drying rate but also improve quality of dehydrated product by expelling intercellular air from the tissues, softening the texture, destroying the enzymes and microorganisms, or by dissociating the wax on the products skin and forming fine cracks in the skin. (Jayaraman and Gupta, 2006) [4] Many researchers have investigated the effect of different pretreatments on various fruits, vegetables and other food drying. (Alvarez *et al*., 1995) [5]. many research on sweet potato flour has focused on the development of new food products using sweet potato flour rather than on efficient methods to produce the flour Meanwhile, researchers have reported different characteristics of Sweet Potato flour processed from different varieties and under different conditions. (Van Hal 2000) [6]. There is need to harmonize and apply some common processing conditions of pretreatment and drying and report the quality of flour. This is important in order to understand the effect of interactions among these independent variables on chemical properties of sweet potato flour.

Processing the sweet potato into flour increases its storage ability and value. It can also be used to enhance food products colour, flavour, natural sweetness and supplement nutrients. In product development, the final quality of a product is highly dependent on the quality of the raw ingredients used. Therefore, if sweet potato flour is to be incorporated into products, it must be good in quality.

2. Material and Methods

2.1 Sample preparation

Samples of sweet potato slices were prepared after sorting based on size, washing and peeling using stainless steel knife manually and slicing with help of adjustable stainless steel slicer. The samples were cut into slices of approximate thickness 6 (±0.1) mm. The details of each pretreatment were described as follow:

The sweet potato slices were pretreated with 1) 0.1% w/v KMS with water solution (1 gm KMS in 1-liter water) for 30 min. 2) 1% w/v Cacl2 with water solution (10 gm $Cacl_2$ 1-liter water) for 1 min. 3) blanching at 80°C for 5 min in water bath. 4) without any pretreatment (control). In chemical pretreatment samples were immersed in chemicals solution in a beaker, which was prepared by adding chemicals with water in desired concentration at room temperature. The ratio of sweet potato slices to the pretreatment solution was 1:5. After the soaking time interval samples were immediately removed and blotted gently using tissue paper. Then slices were weighed again. After the pretreatment, the sweet potato slices was dried in mechanical tray dryer at four different air temperature 50, 55, 60 and 65 ºC. after drying sweet potato slices were grinded then as a quality parameter chemical properties of sweet potato flour like colour, protein, starch, sugar, TSS, ash and fiber content were studied.

Protein content

The crude protein content of the flours was estimated according the Micro kjeldahl method (AOAC, 1990) [7].

Starch content

Starch content of sweet potato flour was determined by Anthrone reagent method as detailed by (Sadasivam and Manickam 1996) [8].

Total sugar content

Total sugar content of sweet potato flour was determined by (Ranganna, 2000) [9].

Total soluble solids

The total soluble solid (TSS) of sweet potato flour was determined with the help of digital refractometer of range (0-53°Brix) which gave the reading directly in degree brix (Ranganna, 2000) [9].

Ash content

5g of sample was weighed into crucible which was heated at low flame till all the material was completely charred and cooled. Then it was kept in muffle furnace as shown in Plate 3.7 for about 5h at 6000C. It was again cooled in desiccators and weighed and repeated until two consecutive weights were constant. The per cent ash was calculated by knowing the difference between initial and final weight. (AOAC, 2005) [10].

Fiber content

Fiber content of sweet potato flour was determined by (AOAC, 2005) [10].

3. Result and Discussion

3.1 Effect of pretreatments on Protein content of sweet potato flour

Perusal of data presented pertaining to effect of pretreatment and drying temperature on protein content of sweet potato flour has been shown in figure 3.1.

As regards to individual effect of pretreatment the protein content was found maximum in case of KMS pretreated and minimum in case of hot water blanching pretreated sweet potato flour. The protein content in KMS pretreated sweet potato flour was found to be 4.59 per cent while in case of controlled, CaCl2 and hot water blanching pretreated flour were found to be 3.91, 4.32 and 3.68 per cent respectively. These results are in good agreement with Olatunde *et al.*, (2015) [11] they found that hot water blanching pretreated flour has lower protein content than sample pretreated with $CaCl_2$.

As regards to individual effect of drying temperature, it was found that as in the increased temperature from 50 °C to 65 °C, the protein content decreased from 4.52 to 3.77 per cent. This is probably due to denaturation of proteins. These results were in good agreement with Pendre *et al.*, (2012) [12] they worked on effect of drying temperature and slice sizes on quality of dried okra.

As regards to interaction between pretreatment and drying temperature the maximum protein content was found to be 5.01 per cent in case of KMS pretreated sweet potato flour at 50 °C and minimum 3.45 per cent in case of hot water blanching pretreated sweet potato flour at 65 °C. Results agreed with Van Hal, (2000) [6] they reported protein content in sweet potato flour is generally low, ranging from 1.0 to 8.5 per cent.

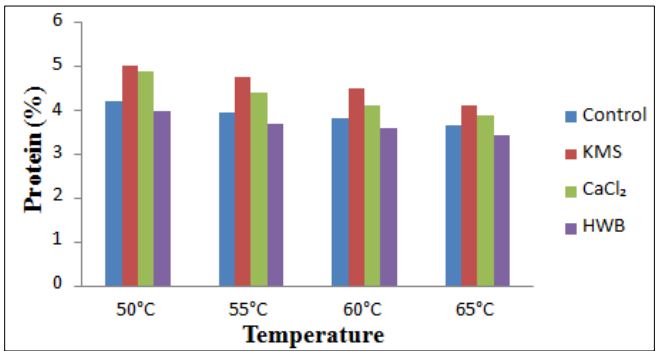

Fig 1: Effect of process variable on protein content (%) of sweet potato flour

3.2 Effect of pretreatments on starch content of sweet potato flour

Perusal of data presented pertaining to effect of pretreatment and drying temperature on starch content of sweet potato flour has shown in figure 3.2. As regards to individual effect of pretreatment the starch content was found maximum in case of controlled samples and minimum in case of hot water blanching pretreated sweet potato flour. The starch content in controlled sweet potato flour was found to be 62.42 per cent while in case of KMS, CaCl2 and hot water blanching pretreated flour were found to be 60.94, 61.70 and 59.34 per cent respectively. The minimum starch content of the flour prepared by hot water blanching treatment might be attributed to leaching out of the starch granules into the blanching water due to plasmolysis. These results were in good agreement with Olatunde *et al.*, (2015) [11] they reported significant variations in values for starch content in the range of 55.76 to 83.65% due to blanching pre-treatments and sulphitation.

As regards to individual effect of drying temperature, it was found that as the temperature increased from 50 °C to 60 °C, the stach content increased from 60.83 to 62.23 per cent, and at 65 °C drying temperature starch content was 59.82 per cent which was lower than 60 °C this is due to gelatinization of the starch. These results were in good agreement with. Khanitta *et al.*, (2016) [13] they reported gelatinization of sweet potato starch occur in the range 60 to 88°C. Drying temperature is positively correlated with amylose content, resistant starch and viscoamylographic properties. It is clear with respect to individual effect of temperature, that the sweet potato flour dried at drying temperature 60 ºC was found better and recorded significantly highest starch content of 62.23 per cent.

As regards to interaction between pretreatment and drying temperature the maximum starch content was 63.48 per cent in case of controlled sweet potato flour at 60°C and minimum 58.31 per cent in case of hot water blanching pretreated sweet potato flour at 65 °C.

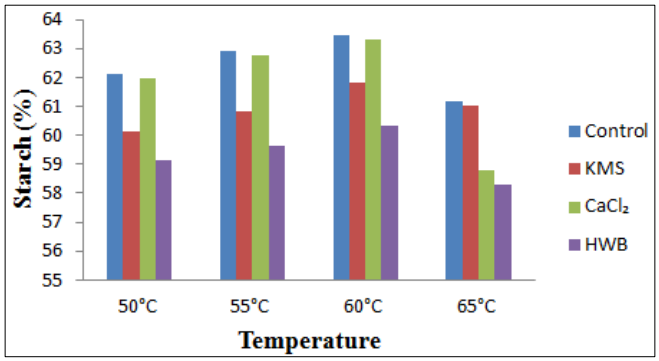

Fig 2: Effect of process variable on starch content (%) of sweet potato flour

3.3 Effect of pretreatments on total sugar content of sweet potato flour

Perusal of data presented pertaining to effect of pretreatment and drying temperature on total sugar content of sweet potato flour has been shown in figure 3.3

As regards to individual effect of pretreatment, total sugar content was found maximum in case of $CaCl_2$ pretreated and minimum in case of hot water blanching pretreated sweet potato flour. The total sugar content in $CaCl_2$ pretreated sweet potato flour was found to be 20.76 per cent while in case of KMS, hot water blanching pretreated and controlled samples were found to be 20.33, 19.67 and 20.52 per cent respectively. The decrease in total sugars content of the flour prepared by hot water blanching treatment might be attributed to more leaching losses of reducing sugars. These results were in good agreement with Ahmed *et al*. 2010 [14] they reported that total sugar was slightly higher in $CaCl_2$ pretreated samples than in blanching and control samples. This slight increase was due to the complexation of sugars by calcium. Samples treated with $CaCl_2$ showed slightly higher total sugar content compared to the control and $NaHSO_3$- treated samples.

As regards to individual effect of drying temperature, it was found that as the temperature increased 50 °C to 60 °C, the total sugar increased from 19.37 to 21.36 per cent, this is probably due to hydrolysis of the disaccharide. At 65°C drying temperature total sugar content was found to be 20.12 per cent which was lower than 60 °C. These results were in good agreement with Ahmed *et al*. 2010 [14] It is clear with respect to individual effect of temperature, that the sweet potato flour dried at drying temperature 60oC was found better and recorded significantly highest total sugar content of 21.36 per cent.

As regards to interaction between pretreatment and drying temperature the maximum total sugar content was found 21.88 per cent in case of $CaCl_2$ pretreated sweet potato flour at 60 °C and minimum 18.88 per cent in case of hot water blanching pretreated sweet potato flour at 50 °C.

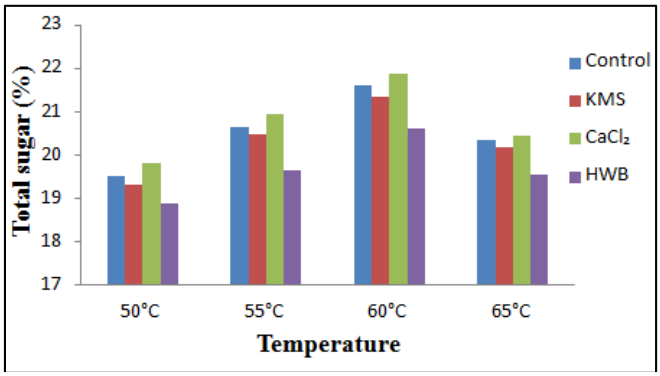

Fig 3: Effect of process variable on total sugar (%) of sweet potato flour

3.4 Effect of pretreatments on total soluble solids (TSS) of sweet potato flour

Perusal of data presented pertaining effect of pretreatment and drying temperature on Total soluble solids (TSS) of sweet potato flour has been shown in figure 3.4

As regards to individual effect of pretreatment the total soluble solids was found maximum in case of $CaCl_2$ pretreated and minimum in case of hot water blanching pretreated sweet potato flour. The total soluble solids in $CaCl_2$ pretreated sweet potato flour was found to be 31.67 °Brix while in case of KMS, hot water blanching pretreated and controlled samples flour were found to be 31.19, 30.90 and 31.13 °Brix respectively. The minimum total soluble solid content of the flour prepared by hot water blanching pretreatment might be attributed to leaching out of the dissolved solids into blanching water from the tissues during blanching. These results were in good agreement with Aina *et al.*, (2009) [15]. They reported significant effect on TSS content of dehydrated onion rings, cauliflower segments and okra slices which were pre-treated with KMS and citric acid before dehydration.

As regards to individual effect of drying temperature, it was found that as the temperature increased from 50 to 65 °C, the total soluble solids increase from 30.16 to 32.20 °Brix However, the results indicate that temperature affects the total soluble solids of the sweet potato flour produced in such a way that as the temperature increased, the total soluble solids increased; this was in accordance with the report of Dereje *et al*. (2009) [16] who indicated that value of total soluble solids of tomato significantly increased after drying at 55, 65 and 75 °C. It is clear with respect to individual effect of temperature, that the sweet potato flour dried at drying temperature 65 ºC was found better and recorded significantly highest total soluble solids of 31.95 °Brix. As regards to interaction between pretreatment and drying temperature the maximum

total soluble solids was 32.86 °Brix in case of $CaCl_2$ pretreated sweet potato flour at 65 °C and minimum 29.85

°Brix in case of hot water blanched sweet potato flour at 50 °C.

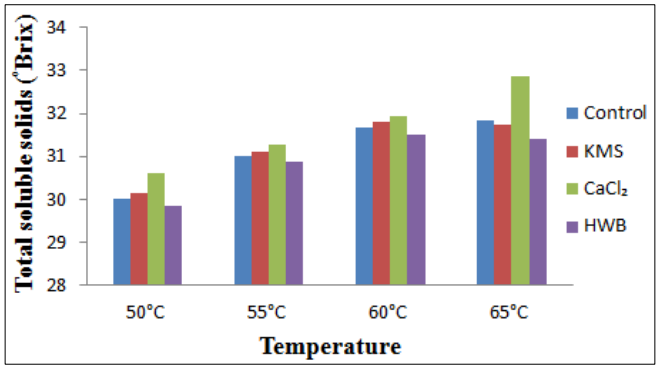

Fig 4: Effect of process variable on Total soluble solids (°Brix) of sweet potato flour

3.5 Effect of pretreatments on ash content of sweet potato flour

Perusal of data presented pertaining to effect of different pretreatments on ash content of sweet potato flour has been shown in figure 3.5

As regards to individual effect of pretreatment the average ash content was found maximum in case of $CaCl_2$ pretreated and minimum in case of controlled sweet potato flour. The average ash content in $CaCl_2$ pretreated sweet potato flour was found to be 2.26 per cent while in case of KMS, hot water blanching pretreated and controlled sample flour found to be 2.19, 2.11 and 2.02 per cent respectively. As expected, ash content were slightly increased in $CaCl_2$ samples compared to KMS, Hot water blanching and controlled samples, this is due to the addition of calcium in the pretreatment step. These results were in good agreement with Ndangui *et al*. (2014) [17]. They reported that ashes were slightly increased in CaCl2 samples compared to blanching and controlled samples, likely owing to the addition of calcium in the pretreatment step.

As regards to individual effect of drying temperature, it was found that as the temperature increased from 50 °C to 65 °C, the ash content decreased from 2.33 to 1.97 per cent, However, the results indicate that temperature affects the ash content of the sweet potato flour produced in such a way that as the temperature increased, the ash content decreased; this was in accordance with the report of Blanco *et al.* (2004) [18] which was on roots and tubers. It is clear with respect to individual effect of temperature, that the sweet potato flour dried at drying temperature 65 ºC was found better and recorded significantly lowest ash content of 1.97 per cent.

As regards to interaction between pretreatment and drying temperature the maximum ash content was 2.46 per cent in case of $CaCl_2$ pretreated sweet potato flour at 50°C and minimum 1.83 per cent in case of controlled sweet potato flour at 65 °C.

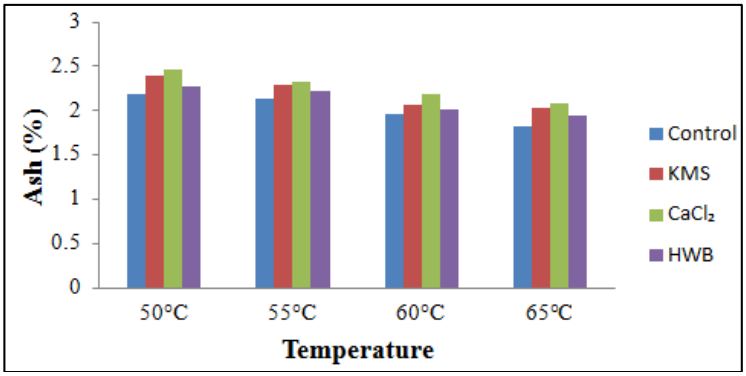

Fig 5: Effect of process variable on ash content (%) of sweet potato flour

3.6 Effect of pretreatments on fiber content of sweet potato flour

Perusal of data presented pertaining to effect of pretreatment and drying temperature on fiber content of sweet potato flour has been shown in figure 3.7.

As regards to individual effect of pretreatment the average fiber content was found maximum in case of CaCl2 pretreated and minimum in case of controlled sweet potato flour. The average fiber content in CaCl2 pretreated sweet potato flour was found to be 0.16 per cent while in case of KMS, hot water blanching pretreated and controlled sample flour found to be 0.14, 0.13 and 0.11 per cent respectively. These results were in good agreement Haruna, *et al*., (2018) [19].

As regards to individual effect of drying temperature, it was found that as the temperature increased from 50 °C to 65 °C, the fiber content was ranged from 0.10 to 0.18 per cent. These results were in accordance with the report of Haile *et al*. (2015) [19] which was on influence of drying temperature on selected properties of flour produced from orange fleshed sweet potato tubers.

As regards to interaction between pretreatment and drying temperature the maximum fiber content was 0.18 per cent in case of $CaCl_2$ pretreated sweet potato flour at 50 °C and minimum 0.10 per cent in case of controlled sweet potato flour at 65 °C.

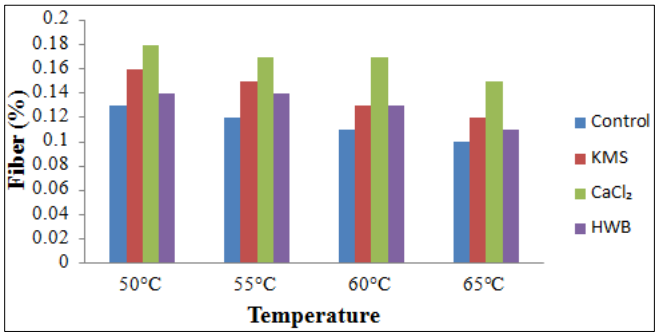

Fig 6 Effect of process variable on fiber content (%) of sweet potato flour

Effect of pretreatments on Colour of sweet potato flour

Colour is often used as an indication of quality and freshness for food products. Hence it has become important for food processors to be able to evaluate and grade their products based on colour. Colour values were measured using a Hunter lab Colourimeter were relative to the absolute value of perfect reflecting diffuser as measured under the same geometric conditions (ASTM methods). Observations were taken at room temperature 30.5°C and 25 per cent relative humidity. Perusal of data presented pertaining to effect of different pretratment and drying temperature on colour of sweet potato flour has been has been shown in figure 3.8

L* value

*L** value represents lightness index of the product, which are represented in Table 4.18. The *L**values of sweet potato flour at various experimental conditions were ranged between 80.94 to 87.38.

As regards to individual effect of pretreatments, the average *L** value was found maximum in case of KMS pretreated and minimum in case of hot water blanching pretreated sweet potato flour. The average *L** value in KMS pretreated sweet potato flour was found to be 86.03 while in case of controlled, CaCl2 and hot water blanching treated flour found to be 83.80, 84.38 and 82.20 respectively. It is clear with respect to individual effect of pretreatments, that the sweet potato flour pretreated with KMS was found better and recorded significantly highest *L** value of 86.03. These results were in good agreement with Ahmed *et al.*, (2010). He studied the effect of pre-treatments on sensory qualities of sweet potato flour and reported higher *L**value due to sulphitation treatment. They reported that sulphite is a good colour preservative and it retards both enzymatic and non-enzymatic reactions.

As regards to individual effect of drying temperature, it was found that as the temperature increased from 60 ºC to 65 ºC, the *L**value of colour was found to be decreased due to elevated temperature. Also the *L**value of colour further decreased with decreased in drying temperature from 60 to 50 °C. It might be due to long period of exposure of hot air during drying. Similar results were reported by Anand, (2005) for onion slices. It is clear with respect to individual effect of temperature, that the sweet potato slices dried with drying temperature 60 ºC was found better and recorded significantly highest colour *L**value of 85.47. The similar results were quoted in case of the convective drying of osmotic dehydrated apple (Kowalski and Mierzwa, 2013). As regards to interaction between pretreatment and drying temperature. The maximum *L** value was found 87.38 in case of KMS pretreated sweet potato flour at 60 °C and minimum 80.94 in case of hot water blanching pretreated sweet potato flour at 65 °C.

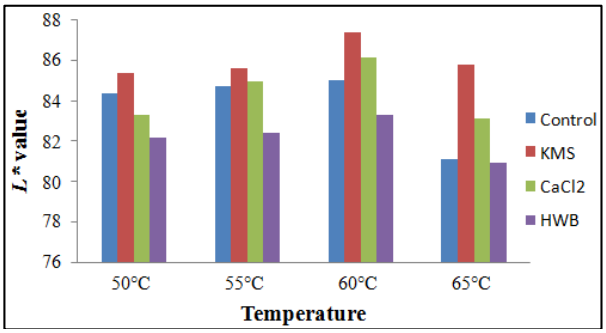

Fig 3.7: Effect of process variable on *L** value of sweet potato flour

4. Conclusions

The following conclusions may be derived from the study:

- Protein content was found maximum for KMS pretreated sample and decreases with increase in drying temperature.
- Starch content was found maximum for control sample at 60 °C followed by $CaCl_2$, KMS and hot water blanching.
- Total sugar content was found maximum for $CaCl_2$ pretreated sample at 60°C
- Total soluble solids (TSS) was found increases with increase in drying temperature and found maximum for $CaCl_2$ pretreated sample at 65 °C
- Ash content was found maximum for $CaCl_2$ pretreated sample and decreases with increase in drying temperature.
- Fiber content was ranged from 0.10 to 0.18 per cent.

The maximum *L** value was found 87.38 in case of KMS pretreated sweet potato flour at 60 °C and minimum 80.94 in case of hot water blanching pretreated sweet potato flour at 65 °C.

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