International Journal of Research and Review
www.ijrrjournal.com E-ISSN: 2349-9788; P-ISSN: 2454-2237

Original Research Article

The Correlation of Colour and Viscosity Changes of Rice Flour with Gelatinization Percentage under Infrared Heating

Gunaratnam Abhiram

Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Sri Lanka.
Department of Export Agriculture, Faculty of Animal Science and Export Agriculture, Uva Wellassa University, Sri lanka.

ABSTRACT

The study was conducted with the objective of finding out the correlation of colour and viscosity changes with gelatinization percentages of rice flour during gelatinization using far-infrared heating. The rice flour was roasted or heated with three far-infrared panel each having 500 W and degree of gelatinization, viscosity and colour changes were measured. The gelatinization percentage, viscosity and browning reaction increases with the far-infrared intensity and exposure time. When the combination of far-infrared intensity and exposure time was higher, a higher gelatinization percentage, viscosity changes and brown colour development were observed. The viscosity changes increased linearly, whiteness reduction (ΔL*) increased exponentially and total color change (ΔE*) increased linearly with the degree of gelatinization. Maximum gelatinization (100%) could be achieved by exposing rice flour to 9000 W/m^2 for 6 minutes. Therefore it can be concluded that there is a strong positive relationship for viscosity and colour development against degree of gelatinization of rice flour gelatinized with far-infrared radiation.

Key words: colour changes, correlation, far-infrared, rice flour gelatinization, viscosity.

1. INTRODUCTION

Rice and rice flour are major food items for South Asian people, as western people more concern on wheat based food products. Heating is probably the oldest technique to preserve and improve the structural and functional quality of the food materials. Infrared radiation is a new addition to heating techniques, but got more attention towards food processing technology. [1] Infrared drying is an effective method of dehydration. FIR radiation energy is transferred from the heating element to the product surface without heating the surrounding air. The near infrared has the frequency of that which evaporates the water molecules from the food material. [2]

Starch gelatinization is a phenomenon which causes the textural and structural changes in the starch molecules due to the loss of birefringence, which uses as a processing technology in most of the starch related industries. The quality of the final product has major concern in a processing technique. The gelatinization percentage, viscosity and colour development are the most relevant parameters which determine the final product of the rice flour. [3]

The dry heat of baking changes the form of starches in the food and causes its outer surfaces to brown, giving it an attractive appearance, flavor and taste. The browning is caused by caramelization of sugars and the Maillardreaction. [4] They both are promoted by heating, but the Maillard reaction caused by reactive carbonyl group of the sugar reacts with the nucleophilic amino group of the amino acid,

and forms a complex mixture whereas caramelization is simply the pyrolysis of certain sugars. [5]

In heating process the flour turn to more rough by losing moisture causes the textural change. [6] Viscosity plays an important role in preparing the food mixture and decides the mixing, pasting ability of rice flour. At the temperature of starch suspension is raised above the gelatinization range, granules swollen if not the available water is not a limiting factor. The viscosity is mainly depending on the collision and shearing of the swollen granules. Since the granule swell with the degree of gelatinization the viscosity also increase as the resistance increase to the rotating spindle of the viscometer. [7] The purpose of this study is to compare the gelatinization percentage with viscosity and colour changes of the rice flour during far-infrared heating.

2. MATERIALS AND METHODS

2.1 Preparation work

The polished rice (*Orizazativaindica*) was grinded and a thin layer of rice flour was prepared. It was roasted by using three ceramic coated FIR elements each having 500 W by changing the combination of FIR intensity and FIR exposure time. Far-infrared intensity was measured with apyranometer (Omni, CMP10). Four levels of FIR density (6400, 7000, 8000 and 9000 W) and seven levels of FIR exposure time (1 to 7 minutes) were selected for the study.

2.2 Iodometric Value

The Iodometric method was followed tomeasure the degree of gelatinization. [8] One percentage concentration starch solution was prepared using rice flour and 1 ml aliquots were treated with 0.1 ml Iodine solution. Absorbance was measured at 600nm against a reagent blank (0.1ml iodine in 10ml of water) by spectrophotometer (Jenway 6305, Japan). Gelatinization percentage was calculated using following equation.

$$Gelatinization\,\% = \frac{spectro\ meter\ reading\ of\ roast\ sample}{spe.reading\ of\ optimum\ gelatinize\ sample}\ X\ 100$$

2.3Viscosity Changes

Viscometer (Tokimac-model BL) was used for viscosity measurements. Three replicates of 55% of rice starch solution were prepared. The No 2 spindle was employed for each treatment, while shear rate was set up at 60 r.p.m throughout the experiment. The dial gauge reading was multiply by 5 (spindle factor) to get the viscosity measurement. [9]

2.4 Colour changes with roasting

Colour was measured in L, a, b colour values using a colorimeter (Minolta CR 300, Japan).The pointer detector gun placed on rice flour in a small bowl with a transparent cover which is providing a uniform surface. The total colour difference (ΔE*) and brightness reduction (ΔL*) was evaluated by comparing the results to those of gelatinize rice flour samples and raw rice flour sample using following equations, respectively. [10]

$$\Delta E* = [(\Delta L*)^2 + (\Delta a*)^2 + (\Delta b*)^2]^{0.5}$$

$$\Delta L* = L_{raw} - L_{gelatinized}$$

2.4 Statistical Analysis

The research was designed with two factor factorial design and data analyzed using ANOVA with 95% confidence interval. Minitab was used to analysis data and Excel was used for descriptive analysis.

3. RESULT AND DISCUSSION

3.1 Iodomatric Value

The gelatinization percentage calculated with refers to the maximum gelatinization is shown in table 1.The gelatinization percentage of the rice flour increase with the FIR intensity for a given exposure time and increase with exposure time for a given FIR intensity. The higher

the intensity higher the gelatinization and similar for the time exposure as well. The maximum gelatinization was gained in the combination of FIR intensity at 9000 W/m^2 and time exposure at 6 minutes. Above this level caused charring of rice flour.

Table 1. Gelatinization Percentages of rice flour samples with different combination of FIR intensity and exposure time

Intensity (W/m^2)				
Exposure time (min)	6400	7000	8000	9000
1	12.93	13.79	26.72	54.40
2	13.79	14.22	29.31	62.89
3	14.66	14.66	30.17	87.93
4	15.52	16.81	32.33	91.38
5	16.38	18.53	33.19	95.26
6	20.26	24.14	40.52	100.00
7	25.00	26.72	52.45	-

3.2 Viscosity changes of rice flour

The viscosity of gelatinized rice flour increases with gelatinization percentage linearly as shown in the Figure 1. Higher the combination of FIR intensity and FIR exposure time, larger the viscosity and gelatinization of rice flour. The correlation coefficient (R^2) for these two variables is 0.9548.

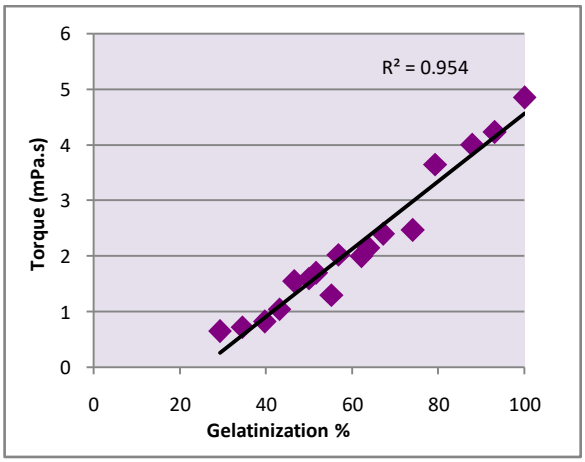

Figure 1. Correlation between gelatinization percentage and viscosity

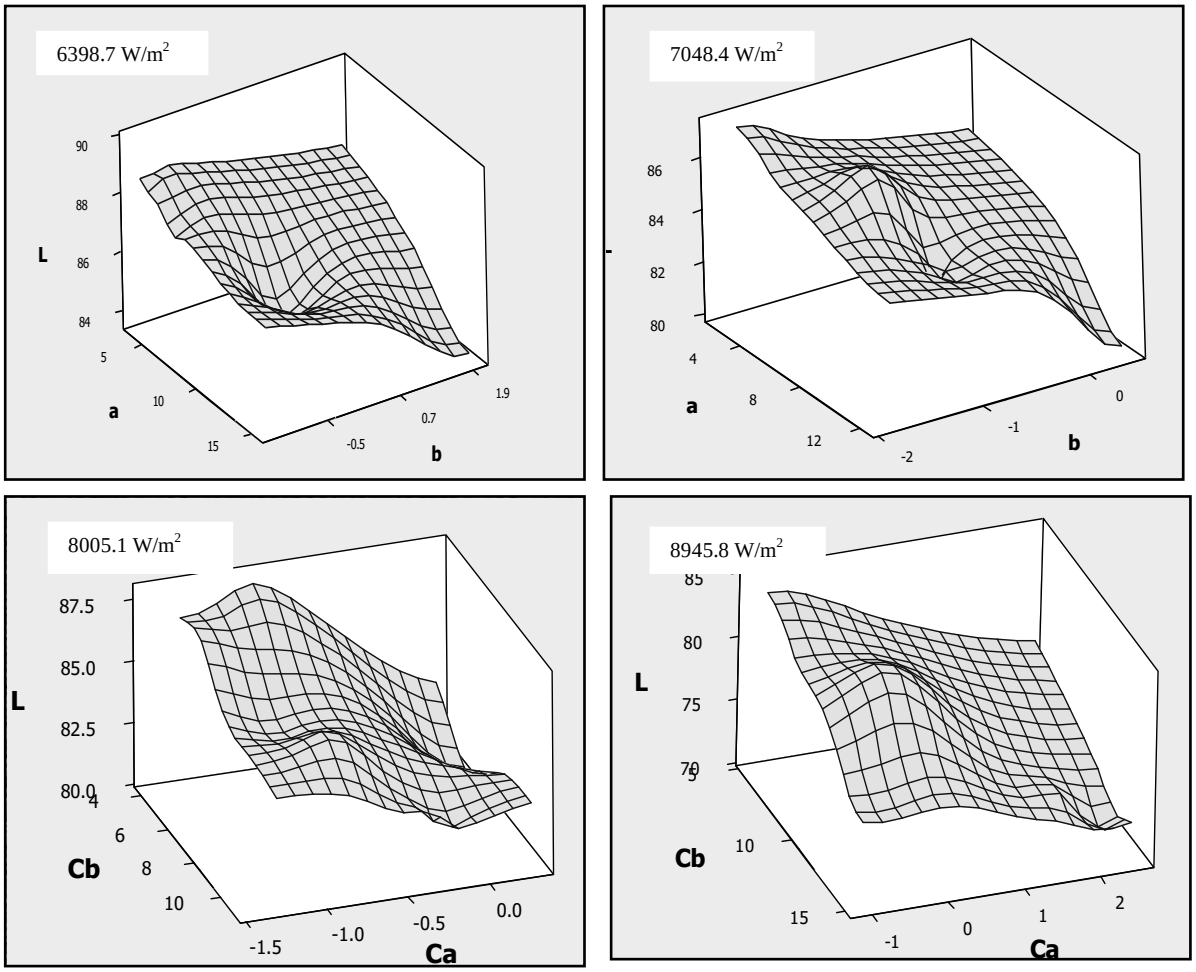

Figure 2. Surface Plot of L, a, b values for different far-infrared intensities

3.3 Colour Changes of rice flour

The browning of rice flour is favored by two reactions called Maillard reaction and caramelization. Both reactions positively correlated with the temperature. The colour changes (L, a, b values) were not evenly changed with time of roasting, which is represented by the up and downs in the surface plot shown in Figure 2. With the IR intensity a, b values increases and L value decreases. For all the FIR intensities a, b values increase and L value reduces with the time.

The whiteness reduction (ΔL*) increases exponentially with FIR intensity and the exposure time according to the Figure 3. Higher the combination of FIR intensity and FIR exposure time, higher the whiteness reduction. The increment of FIR intensity and exposure time obviously increase the temperature of the rice flour, result of increasement of the browning reaction. The correlation coefficient (R^2) is 0.8268.

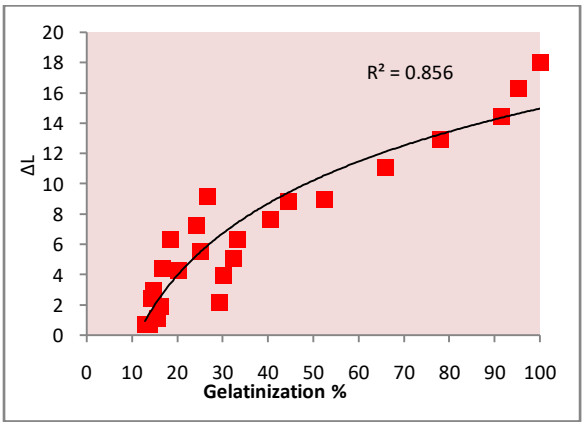

Figure 3. ΔL* changes with the gelatinization percentage

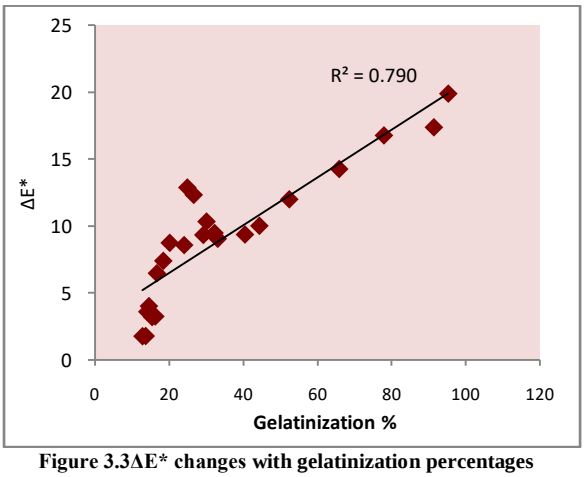

Figure 3.3ΔE* changes with gelatinization percentages

The Figure 3.3 shows the total colour changes (ΔE*) increase linearly with the gelatinization percentage and higher the gelatinization percentage higher the total colour change. ΔE* give a good represent of the all coordinate of the colour change which include all three L, a, b values. The correlation between gelatinization percentage and total colour changes is strong with correlation coefficient (R^2) of 0.7002.

CONCLUSION

The Iodometric method gives good representation of the gelatinization percentage of the roasted rice flour. There is strong correlation for viscosity changes and colour changes with gelatinization percentage of rice flour. Therefore viscosity changes and colour changes can be used as a good indicator for degree of gelatinization in far-infrared gelatinization.

REFERENCES

1. Afzal, M. T. 2003. Intermittent far infrared radiate on drying. *The society for engineering in agricultural, food, and biological systems*. ASAE 036201.
2. Sakai, N. and Hanzawa, T., 1994. Applications and advances in far-infrared heating in Japan. *Trends in Food Science & Technology*, 5(11), pp.357-362.
3. Udachan, Iranna, S., Sahoo, A. K. and G.M. Hend. 2012. Extraction and characterization of sorghum (Sorghum bicolor L. Moench) starch. *International Food Research Journal*, 19(1):315-319.
4. Correia, P., Leitão, A. and Beirão-da-Costa, M.L., 2009. The effect of drying temperatures on morphological and chemical properties of dried chestnuts flours. *Journal of Food Engineering*, 90(3), pp.325-332.
5. Capuano, E., Ferrigno, A., Acampa, I., Serpen, A., Açar, Ö.Ç., Gökmen, V. and Fogliano, V., 2009. Effect of flour type on Maillard reaction and acrylamide formation during toasting of bread crisp model systems and mitigation strategies. *Food Research International*, 42(9), pp.1295-1302.

6. Alexander, R. J. and H. F. Zobel. 1993. Development in carbohydrate chemistry. AACC, Minnesota, USA.
7. Fennema, O. R. 1984. Principle of food science. Marcel Dekker, INC., New York and Basel, USA.
8. Wootton, M. and H. P. Kensington. 1989. Alkali gelatinization of Wheat starch. *Transaction of the Starch* 41(7): 261–265.
9. Shuey, W.C., 1975. Practical instruments for rheological measurements on wheat products. *Cereal Chemistry*, 52(3), pp.R42-R81.
10. Biller, E. and A. Ekielski, 2007. Application of instrumental colour measurement as an indicator of changes occurring in wheat bakery products during production process. *Polish journal of food and nutrition sciences*, 57 (2A), 29-34.

How to cite this article: Abhiram G. The correlation of colour and viscosity changes of rice flour with gelatinization percentage under Infrared heating. International Journal of Research and Review. 2018; 5(2):36-40.

******