INFLUENCE OF THERMAL TREATMENT ON THE COLOR OF MAIZE STARCH GEL

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Abstract
This paper presents the results obtained after experiments concerning on the influence of thermal treatment on color of maize gel colored with carminic acid and colorant Ponceau 4R. Model systems analyzed were maintained on the thermostat for 15 minutes, respectively, 30 minutes, at a temperature of 40^0C, 55^0C and 70^0C. Transmittance of samples was measured before and after the heat treatment, with the spectrophotometer Spekol provided with re-emission accessory R 45/0.
The intensity of light reflected on the surface sample was transformed in Hunter coordinates. with the following relations: $L = 100\sqrt{Y}$; $a = \frac{175}{\sqrt{Y}}(1{,}02X - Y)$.
Was obtained a decrease of lightness for the maize starch gel wich was maintain in the thermostat at 40^0C and 55^0C, and an increase of the redness.
However the mentain of gels at 70^0C led at the increase of the lightness and the decrease of the redness. The variaion of lightness and redness for the maize starch gel wich was colored carminic acid, have the bigger values than the variation of the Hunter's coordinates of the maize starch gel which was colored with Ponceau 4R

Keywords: maize starch gels, carminic acid, Ponceau 4R, lightness, rednness

1. INTRODUCTION

The color has an important role in the acceptability of foods. The consumer judges first the quality of the food product after his color. The color becomes this way an indicative of food quality, being one of the first perceptible characteristics with the help of senses and used by consumer before accepting the aliments [1].
Boki and others, in 1991, studied the adsorption of colorants on starch materials [2].
Maize starch is one of the cereals of worldwide importance; this grain is used for human consumption and also has important industrial applications [3].
Carminic acid has been used as a colorant even in the ancient civilizations be it the Egyptian, or the Maya or the Inca. Cochineal is a red coloring matter consisting of the dried bodies of the female insect Coccus cacti (Dactylopius coccus Costa, Fam. Coccidae), containing eggs and larvae. The insect grows on various species of the cactus, Nopalea (Fam. Cactacea), in the Canary Islands and Central America. The insects are collected and killed by immersion in scalding water, heated ovens, or long exposure to the hot sun. Dried cochineal contains up to about 22 % carminic acid, which is its principle colorant extracted from the ground insect mass[4]. The chemical structure of carminic acid consists of a core anthraquinone structure linked to a glucose sugar unit. Ponceau 4R is a red azo dye usually synthesized from coal tar which can be used in a variety of food products [5]. The usage of different colorants in food is liquidated by the legislation of each country, and the legislation is more and more restrictive, confining the number of colorants and their maximum permissible dose in food products.
Colorants adsorption on the different substrates is influenced by chemical structure of the colorant and of the used substrate [6]. Also, recent research had shown that the coloring power depends on the type of interaction colorant with the used substrate [7].

Calvo and Salvador studied gels color stability during storage, in 2000. The colors of alimentary gels influence the product's color, becoming this way a decisive agent in the consumer's accepting or repulsing [8].
Native starch granules, as appear in raw foods, are mostly indigestible. Gelatinization of starch occurs when foods are heated in an excess of water. During the gelatinization process, starch granules swell and gradually lose their molecular order; the amylose chains solubilize and a starch gel is formed [9].
Experimental research is conducted to study changes in the color of the maize starch gel colored with carmine acid and colorant Ponceau 4R maintained for 15 respectively, 30 minutes at different temperatures.

2. MATERIALS AND METHODS

Experiments were conducted using maize starch from (S.C. Farmechim 10 Ploiesti, Romania), carmine acid, E-120, and colorant Ponceau 4R, E-124, (S.C. Rollit, Romania).
The maize starch gels, colored with carmine acid or Ponceau 4R were obtained by the method proposed by Alonso-Garcia, A., et al. in 1999 [10]. 5 g starch is dispersed in 40 ml distilled water. The suspension thus formed is homogenized and thermostat for 20 minutes at 70^0C.
The amount of dye is added 0,01% and was calculated so that the maximum dose allowed in meat products (100 mg dye/kg product for acid carmine and 100 mg dye/kg product color Ponceau 4R) according to Health Ministry Orders 438/295 in 2002 [11].
Color of the gels was measured before and after thermostation samples for 15 minutes and 30 minutes at a temperature of 40^0C, 55^0C or 70^0C.
To measure the color used spectrophotometry Spekol 10 where was mounted accessory which R 45/0. Reading was compared with a standard sample represented an area of white magnesium oxide, which is characterized by the following values of the trichromatic coordinates: X = 98, Y = 100, Z = 118 and the following trichromatic coefficients: x = 0.310, y = 0.3164, z = 0.3734. The intensity of light reflected from the surface sample, measured after cooling the sample at room temperature, was expressed in units Hunter with relations:

$$L=100\sqrt{Y}\,; \qquad a=\frac{175}{\sqrt{Y}}(1{,}02X-Y)$$

where L is the brightness (lightness), and a represents the degree of red (rednness) of the maize starch gels colored with acid carmine or colorant Ponceau 4R.

3. RESULTS AND DISCUSSIONS

The intensity of light reflected on the sample's surface was transformed in Hunter coordinates, and after that the color differences ΔL and Δa were calculated. The acquired results for the maize starch gel colored with carminic acid are presented in table 1.

Table 1. The color differences of maize starch gels, colored with carminic acid.

Colorant	Temperature [^{o}C]	Time [min]	ΔL	Δa
PM1-A.C.	40	0	-	-
A.C.	40	15	-0,3	1,1
A.C.	40	30	-0,42	1,35
PM2-A.C.	55	0	-	-
A.C.	55	15	-0,55	1,3
A.C.	55	30	-1,05	1,73
PM3-A.C.	70	0	-	-
A.C.	70	15	0,71	-1,25
A.C.	70	30	1,35	-2,5

The blank sample corresponding to the 40^0C temperature was noted with PM1-AC, that has the lightness and the redness degree corresponding to the time T=0 minute. PM2 represents the blank sample corresponding to the 50^0C temperature, and PM3 represents the

blank sample corresponding to the 70^{0}C temperature. Carminic acid was noted with AC. Seeing that the algebraic sign of maize starch gel lightness difference (ΔL), maintain in thermostat at 40^0 or 50^{0}C temperature, is negative, means that the color of samples becomes darker, and at 70^{0}C temperature, when the lightness difference becomes positive, the samples are brighter.

For the redness degree difference (Δa) of thermostated samples at 40^{0}C and 50^{0}C temperatures are obtained positive values, the samples becoming redder, while for the Δa difference for thermostated samples at 70^{0}C temperature we've obtain negative values.

In the figure 1. was represented graphically the variation of the redness in relation to temperature of the maize starch gel colored with carminic acid, and in figure 2. the variation of lightness in relation to temperature.

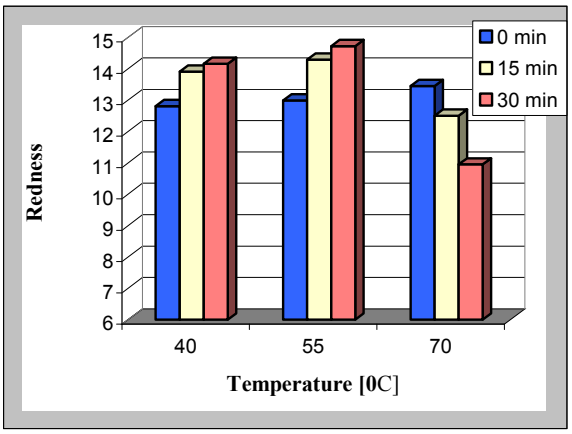

Figure 1. Changes in the of the redness colored maize starch gel with carminic acid

Thermostated gels at 40^{0}C or 55^{0}C enhances the degree of red starch gels stained with samples carminic acid but brightness decreases, while on control samples to 70^{0}C temperature lowers the level of red samples and increase brightness.

The largest increase the red is obtained by a thermostatic for 30 minutes at 50^{0}C, its value being 13.3% higher than the sample before on control. The degree of red sample thermostated at 70^{0}C for 30 minutes is 18.5% lower than the level of red non thermostated.

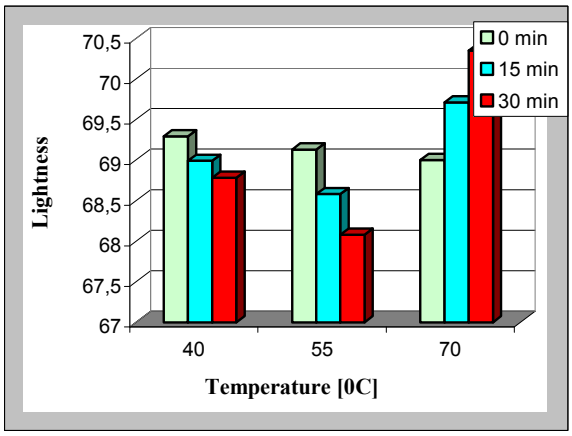

Figure 2. Changes in the of the lightness colored carrageenan gel with carminic acid

For the second analyzed colorant, Ponceau 4R, are obtained the color differences presented in table 2

Table 2.The color differences of maize starch gels, colored with colorant Ponceau 4R.

Colorant	Temperature [^{o}C]	Time [min]	ΔL	Δa
PM1-P4R	40	0	-	-
P4R	40	15	-0,25	1,05
P4R	40	30	-0,41	1,33
PM2-P4R	55	0	-	-
P4R	55	15	-0,53	1,31
P4R	55	30	-1,07	1,74
PM3-P4R	70	0	-	-
P4R	70	15	0,94	-0,36
P4R	70	30	1,4	-0,56

The blank sample corresponding to the 40^{0}C, 55^{0}C and 70^{0}C temperatures were noted with PM1-P4R, PM2-P4R and PM3-P4R. Colorant Ponceau 4R was noted with P4R.

Color differences ΔL and Δa of maize starch gel colored with Ponceau 4R and thermostated at 40^{0}0C and 55^{0}C , has proximate values to

color differences of samples of colored with carminic acid. Instead of color differences, ΔL and Δa, have lower values for maize starch gel colored with Ponceau 4R (77%) compared to samples stained with carmic acid, thermostatic at 70^0C.

The heat treatment influence on redness degree of maize starch gel samples was graphically presented in figure 3, colored with Ponceau 4R, and the influence of heat treatment on lightness in figure 4.

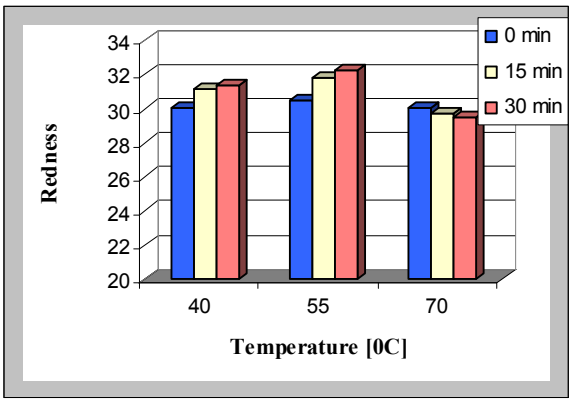

Figure 3. Changes in the of the redness colored maize starch gel with colorant Ponceau 4R

The redness degree increase by 5.7% if it keeps by thermostat for 30 minutes at 55^0C and it will decrease by 1.8% after a thermostating for 30 minutes at 70^0C.

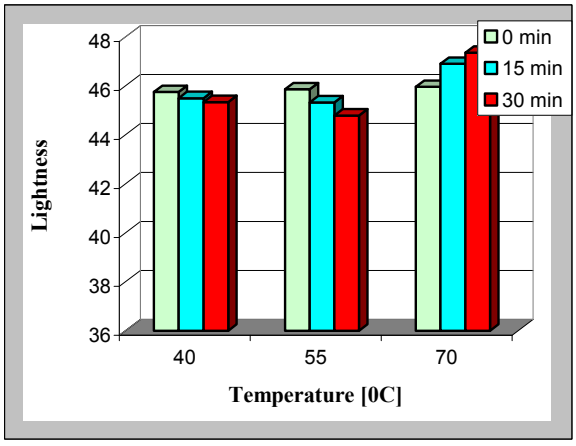

Figure 4. Changes in the of the lightness colored carrageenan gel with colorant Ponceau 4R

Lightness of the thermostated maize starch gel gels colored with carminic acid after 30 minutes at a temperature of 70^0C is 3% higher than the initial lightness of gel, and after a thermostation of 30 minutes at a 55^0C temperature is 2.5% less than the initial brightness of maize starch gel.

4. CONCLUSIONS

The following conclusions are made evident according the made experiments:

- parameters that define the color (lightness and redness degree) of maize starch gels colored with carminic acid or Ponceau 4R colorant varies during the heat treatments. The variation of these parameters depends on the temperature and the time of heat treatment, and also on the used colorant;
- redness degree of samples varies in inverse proportion with lightness. The amidon starch gels colored with carminic acid or Ponceau 4R and thermostated at below 70^0C temperature, respectively 40^0C or by 55^0C for 30 minutes, recorded increase redness and decrease lightness. This behavior is due, mainly, to dehydration gels leading to increasing concentration of the colorings in the samples;

Thermostating the gels at 70^0C temperature, influences differently the color parameters, in the terms of used colorant. Therefore, the gel's redness degree colored with carminic acid, thermostated for 30 minutes at 70^0C, decreases with 3,47 times more than de redness degree of Ponceau 4R colored gel.

5. REFERENCES

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