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*Original Paper*

# Maintain the Chili Colour of a Sea-food Dipping Sauce in Product Processing

W. Puminat[1*]

[1] Division of Food Chemistry and Physic, Institution of Food Research and Product Development, Kasetsart University, P.O.box 1043, Kasetsart Bangkok, 10900 Thailand

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***Abstract***

*Products of sea-food dipping sauce were prepared by sugar, water, acid, salt with chili and herbs. In the experiments, products were prepared and designed on a factor model for the study on the program. They were designed as factorial 4×2×4 by management with RBCD on conditions model of blanching, heating and cooling for the study on chili colour. The results of the experiments performed on physicochemical properties of product such as Brix 50.0-66.9 pH 3.52-4.29, Aw 0.814-0.879, solid content 2.80-5.75 g/100g, chlorophyll a 0.20-1.66, chlorophyll b 1.38-4.13. Colour value of products was $L^*$29.99-23.97, $a^*$-2.56- -3.0 and b*8.28-1.21. The green value of products was preserved green colour for processing on blanching, short-time heating and all cooling. The color preservation of chili depended on the preparation process. Blanching and cooling supported to preserve the colour and decreasing of decay texture. Usage chemicals as $Ca^{2+}$ and $Mg^{2+}$ treatment.in processing of products were preserved a green colour more than no chemical treatment. Blanching, cooling and short time for cooking were product development in order to preserve the green colour. The stability of the color of product was improved by blanching and cooling including boiling with short time.*

***Keywords***

*chilli color, dipping sauce, color preservation*

## 1. Introduction

Chlorophyll is a green plant pigment that is important function of plant physiology as well as the possible health effects. Chlorophyll is found in the chloroplasts of plants. There are various types of chlorophyll structures but plants contain chlorophyll a and b. Chlorophyll a has blue-green color. Chlorophyll b has green-yellow color. Chlorophyll has antioxidant and anti-inflammatory properties that prevent chronic diseases such as cancer. A molecular structure of chlorophyll is similar to heme

Chlorophyll has magnesium as its central metal ion, and the large organic molecule to which it bonds is known as a porphyrin. Heme consists of a porphyrin similar to that in chlorophyll with at its center. Heme is bright red, the pigment that characterizes red blood. In the red blood cells of vertebrates, heme is bound to proteins to form hemoglobin. Heme is the red pigment of blood in humans and animals whereas in the central atom of heme is an iron (II) ion. The metal in the center of chlorophyll molecule is magnesium. It makes chlorophyll remains green. The sea salt in cooking composes of sodium or magnesium ions replaces in food it will also have green vegetables are fresh. Therefore, the addition of salt to the vegetables boiling are preserved green vegetables, it makes pretty fresh. if we boiled vegetables for a long time the vegetables had been a pale color. In acid conditions, added lemon juice in vegetable for cooking changes color from green to brown. Porphyrin structure of chlorophyll replaces with hydrogen ion in reaction and changes to a reddish brown. Frozen vegetables should be blanched and decreased temperature with cold water such that green vegetables are fresh longer. To add a little oil in vegetable, it will coat the cell walls of vegetables that are boiled. More flexible And the surface of the vegetables are even more luster. It makes a green shadow more.

Chili is an ingredient to enhance the color, flavor and aroma in food. It is also used as economic plant for medicinal plant and product food. Several types of food products contain chili such as chili dipping sauce, chili sauce and canned food. Some are used as a cooking ingredients and main ingredient is chili pepper and paste chili. They are used to season a dish after preparation. The chlorophyll green gives fresh color for various food. Colour of chlorophyll has unique characteristics that can degrade through enzymatic and non-enzymatic reactions. The Maillard reaction and oxidation make change to dark brown. Usage high-temperature processing of the product degraded green colour through several processes. Chlorophyll degradation progresses rapidly as the chlorophyll structure changes into its derivative compounds that result in its green color. The discoloration of green chlorophyll change into dark-green, yellow or black. one of the most important qualities is control parameters in process of industry.

## 2. Materials and Methods

*2.1 Processing of a Sea Food Dipping Sauce from Chili*

2.1.1 Preparation of Chili by Chemical Treatments for Process

5% of Chemicals ($Ca(OH)_2$, MgO, $MgCl_2$ and $CaCl_2$) were prepared by dissolve with distillation water. Chili was soaked in chemicals of the following solutions over night or about 5hrs. They were eluted with filtered water 2L for three times. They were drained until dry and packed in cool stores for the next to product preparation.

2.1.2 Steps on the Preparation of Product

To boil the mixing of water and sugar until boiling

⇩ added acid and salt

⇩ added herbs and chili (blanching or no blanching)

⇩

To cook by heating and cooling or no cooling

2.1.3 Study on Temperature and Time on the Process

Blanching was a heat treatment by steaming and followed by cooling with low temperature or room temperature. Blanching, heating and cooling were important for processed products. There was study on time of blanching as 0, 1 and 3 min for the difference of chili colour before processing of product. In the processing, they were divided into 6 groups as the following:

BCC = Blanching and Cooling with Cooling after process heating

BCN = Blanching and Cooling with No cooling after process heating

BNC = Blanching and No cooling with Cooling after process heating

BNN = Blanching and No cooling with No cooling after process heating

NBC = No blanching with Cooling after process heating

NBN = No blanching with No cooling after process heating

2.1.4 Experimental Designs for the Product of Processing

In the experiments, products were designed on a model of preparation and factor of conditions for the study on chili colour. They depended on chili groups, bleaching, heating and cooling. The experimental design was factorial $4 \times 2 \times 4$ by management with RBCD model as 2 blocks. The first factor was four groups of fixing colour as $Ca(OH)_2$, MgO, $MgCl_2$, and $CaCl_2$. The second was two types of bleaching and no bleaching. The third was bleaching by with or without cooling and with or without cooling after heating. Products of processing were kept on study the quality and property of characteristics.

*2.2 Physicochemical Properties*

2.2.1 Dry Weight of Product and Preparation of Sample Solid

The sample solid was prepared by filtration and drying. The sample was filtrated with gauze cloth. Residue from the filtration was made for drying with vacuum oven at 50 ℃ 7hrs. The drying sample was kept in vial with screw cap for colour measurement.

2.2.2 Soluble Solid Content or Degrees Brix ($^{o}$Bx)

The Brix scale or degrees Brix ($^{o}$Bx) was numerically equal to the percent of dissolved solids in the products. The soluble solid content was determined by using a refractometer (Abbe Refractometer, model). % Brix of a solution was performed by refractive index of a solid-containing solution. Three determinations of each sample were taken with triplicate readings.

2.2.3 Measurement the Green Colour of Chlorophyll

Drying solid was packed in a transparent bag and mixture sample was taken in the transmission compartment for determination of colour value. All samples were measured a colour by reflectance and transmission with the Data Colour International Measurement model *Colour Tools* by transmission compartment. CIE value (*Commission Internationale de I'Eclaerage*) display colour value in CIELAB system. L*(0 = black and 100 = white), a*(-a* = green and +a* = red) and b*(-b* = blue and +b* = yellow) at D65 10Deg (Light source Illuminant D).

2.2.4 Determination of Chlorophyll Content

Samples were stirred together and mixed until homogeneous. After that sample was allowed to separate the layers. A transparent layer of 1ml dipping sauce was soaked and extracted with 10 ml acetone in vial with screw cap by vortex mixer for 30 min. Mixer solution was centrifuged at 4,500 rpm for 20 min. The upper layer was supernatant for chlorophyll analysis by UV-visible spectrophotometer at absorbance of wavelength 645 and 663 nm. To calculate the amount of chlorophyll a and chlorophyll b by equation below.

Chlorophyll (a) = [12.7 (OD663) -2.69 (OD645)] x V /1000 x Wt

Chlorophyll (b) = [22.9 (OD645) -4.68 (OD663)] x V /1000 x Wt

(OD = absorbance of the sample V= volume of the solution sample Wt. = weight of the sample).

2.2.5 Determination of β-carotene Content

Samples were soaked and extracted with acetone-hexane mixture (10:1) by vortex mixer. Extracts were centrifuged at 4500 rpm 30 min and upper transparency of the sample was determined total carotene content using the established method of UV-visible spectrophotometer at wavelength 445 nm.

2.2.6 Measuring the Water Activity (Aw)

Aw was equilibrated and measured at 25 ℃ by an instrument of The Novasina LabMASTER-Aw. The water activity was recorded with Sorption behavior of water and bounded water in food Water activity was usually controlled by the use of salt or sugar. Changing the Aw of the finished product indicated the process and changes in ingredients.

2.2.7 pH Measurement

The pH (Sartorius model Docu-pH+ meter) was calibrated according to the manufacturer's instructions using buffer standards of pH 7 and pH 4. The pH meter was immersed in the sample. The pH value of each product was measured and recorded the values of the concentration of the acidity.

*2.3 Statistical Analysis*

Statistical analysis of mean and variance in each treatment was taken with Duncan's new multiple range test at the significance level of $p \leq 0.05$ by SPSS (Statistical Package for the Social Sciences) program. In each treatment was scaned and checked the correlation in order to compare the differences at $p \leq 0.05$ and $p \leq 0.01$ level (2-tailed). The data were analyzed by statistical program of ANOVA and the average treatments were analyzed by Duncan New's Multiple Range Test at significant level.

## 3. Results and Discussions

*3.1 Characteristics of Products and Quality of Colour*

Products of sea food dipping sauce were prepared in ingredients with proportion by Figure1. The products were classified the food processing by pH< 4.5 as low acidity food. The buffer of sodium acetate/acetic was shown pH value as acids and measured in the pH range 3.7-5.6. The acidity of product should be satisfied with preparation at pH range 3.40 -3.75. Acid and salt of ingredients kept pH buffer and control the sour taste of product quality.

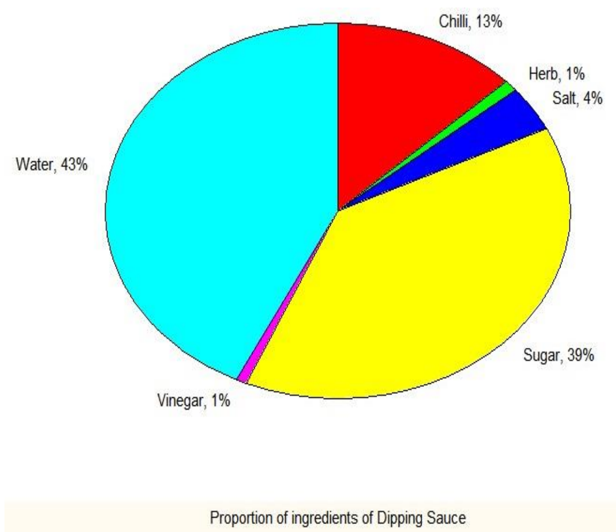


**Figure 1. The Percentage of Ingredients for Preparation of Sea Food Dipping Sauce**

In the experiments, blanching was done by heating and the temperature cool down so that the chilies were destroyed the enzyme and reduced the number of microorganisms. While it was cooked together with all ingredients for the product, chili color depended on the preparation process. The measured values were claimed to better preserve the quality of green colour. Process of blanching, cooling and treatment of chemicals ($Ca^{2+}$, $Mg^{2+}$) were shown the color enhancer. Blanching and cooling supported to reduce the decay of chilies and become tender more. The green value of products was increased for process on blanching and all cooling. Time of chili blanching with 5 min indicated less green color than 3 min.

*3.2 Statistical Comparisons of the Different Processing and Treatments*

**Table 1. Influence of Blanching and Thermal Cooking in Process on the Difference of Products and Total Individual Quality**

| Sample | CIELAB colour | | | | | |
|---|---|---|---|---|---|---|
| | All products of sea food dipping sauce chili | | | Dry solid of sea food dipping sauce chili | | |
| | L* | a* | b* | L* | a* | b* |
| Classification of product by heating and cooling | | | | | | |
| BCC | 27.31±0.25$^{e*}$ | -1.60±0.64$^{f*}$ | 5.18±0.91$^{ef*}$ | 49.74±6.96$^{ab*}$ | 2.41 ±1.04$^{a*}$ | 26.82±2.72$^{b*}$ |
| BNC | 26.22±0.25$^{e*}$ | -1.27±-0.45$^{f*}$ | 4.67±0.40$^{ef*}$ | 49.09±5.37$^{ab*}$ | 2.74±1.02$^{a*}$ | 26.77±1.85$^{b*}$ |
| BCN | 28.28±1.14$^{e*}$ | -1.68±0.69$^{f*}$ | 5.65±1.94$^{ef*}$ | 48.10±4.41$^{ab*}$ | 2.82±0.99$^{a*}$ | 26.64± 1.86$^{b*}$ |
| BNN | 26.84±1.23$^{e*}$ | -1.23±0.46$^{f*}$ | 5.24±1.10$^{ef*}$ | 49.38±6.23$^{ab*}$ | 2.76±0.87$^{a*}$ | 27.28±2.81$^{b*}$ |
| NBC | 26.51±2.23$^{e*}$ | -1.52±0.86$^{f*}$ | 5.22±1.54$^{ef*}$ | 50.96±4.80$^{ab*}$ | 2.32±0.80$^{a*}$ | 27.36±1.33$^{b*}$ |
| NBN | 27.83±0.74$^{e*}$ | -1.41±0.28$^{f*}$ | 5.25±1.34$^{ef*}$ | 47.69±5.65$^{ab*}$ | 2.96 ±1.19$^{a*}$ | 25.97±3.16$^{b*}$ |
| Classification of product by chemicals treatment | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| None | 24.98 ±4.93 [bd*] | 2.37 ±5.16 [bc*] | 5.57 ±4.09[cd*] | 44.76 ±3.33[a*] | 3.25 ±0.73[a*] | 24.78 ±1.96[*] |
| $MgCl_2$ | 26.27 ±1.40 [bd*] | -0.86 ±0.44 [bc*] | 4.51 ±1.86[cd*] | 52.14 ±3.05[a*] | 2.76 ±1.13[a*] | 28.31 ±2.10[*] |
| MgO | 27.39 ±1.56 [bd*] | -1.77 ±0.55 [bc*] | 5.68 ±1.42[cd*] | 52.25 ± 4.29 [a*] | 3.29 ±0.88[a*] | 27.37 ±2.03[*] |
| $Ca(OH)_2$ | 27.64 ±1.11 [bd*] | -1.49 ±0.45 [bc*] | 5.00 ±1.13[cd*] | 54.04 ±4.35 [a*] | 2.60 ±1.00 [a*] | 27.91 ±1.65[*] |
| $CaCl_2$ | 27.35 ±0.80 [bd*] | -0.98 ±0.27 [bc*] | 4.51 ±1.01[cd*] | 52.15 ±2.38 [a*] | 2.18 ±0.62 [a*] | 27.46 ±1.18[*] |

[*] mean the values in a row are significantly different at $p \leq 0.05$ (2-tailed). [abc] mean the correlation by regression of the same alphabet are significant at $p \leq 0.05$ (2-tailed). [def] show the correlation of the same alphabet are significant at $p \leq 0.01$ (2-tailed).

The different letters in the same column indicate a significant difference at the level of $p \leq 0.05$. The differences of row L*, a* and b* for blanching, heating and cooling were significant at $p \leq 0.05$. Average mean of L*, a* and b* for a kind of process by blanching and cooling were significantly different at the level of $p \leq 0.01$. All products by processing with heating and cooling of BCC, BCN, BNC, BNN, NBC and NBN had significantly a difference at the 0.01 level (2-tailed). Blanching and no blanching process, the pearson's correlation coefficient ($R_x$) of BCC, BCN, BNC with BNN were highly 0.984, 0.989 and 0.989 at the level of $p \leq 0.01$. NBC and NBN were highly the correlation as $R_x = 0.991$ at $p \leq 0.01$. But blanching and no blanching process were not the correlation at the level of $p \leq 0.01$.

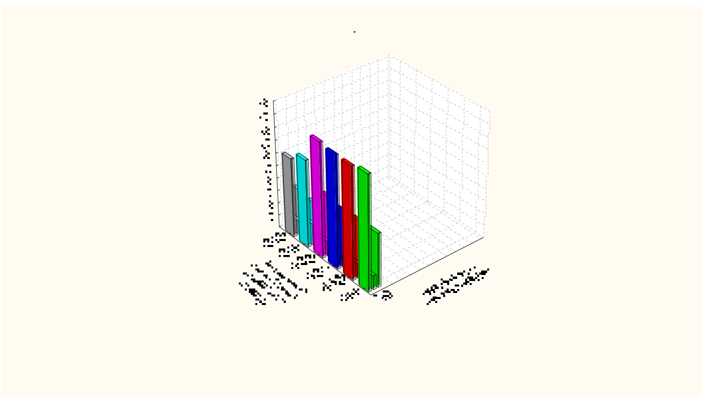

**Figure 2. Colour Value and Product of Classification by Processing Six Groups with Heating and Cooling**

The differences between types of chlorophyll was displayed physicochemical properties and colour. Chlorophyll a and chlorophyll b were orderly bluish-green and yellow-green. The green value of products was increased for process on blanching and all cooling. Average mean of L*, a* and b* for a difference of row by blanching, heating and cooling were significant at $p \leq 0.01$. Colour of chlorophyll content was determined along prepared treatments in order to assess both the comparative evaluation process and the quality of the green index. The chlorophyll of BCC, BCN, BNC, BNN, NBC and NBN indicated a significant difference at $p \leq 0.05$.

**Table 2. Comparison of Identity and Properties of the Processed Product in Each Group**

| Samples | β-carotene ± SD | Bx ± SD | pH ± SD | Aw ± SD | % Dry wt. ± SD | Chlorophyll ± SD | |
|---|---|---|---|---|---|---|---|
| | | | | | | Type a | Type b |
| Classification of product by time for blanching | | | | | | | |
| None | 0.20 ±0.01* | 54.20 ±2.54xW* | 3.72 ±0.17xZ* | 0.873 ±-0.008Z* | 4.01 ±0.50* | 0.84 ±0.29y* | 2.72 ±0.78y* |
| 1min | 0.19 ±0.03* | 53.98 ±1.79xW* | 3.75 ±0.20xZ* | 0.872z ±0.006Z* | 4.40 ±0.88* | 0.77 ±0.35y* | 2.63 ±0.55y* |
| 3 min | 0.17 ±0.01* | 56.20 ±2.60xW* | 3.72 ±0.04xZ* | 0.853z ±0.019Z* | 4.61 ±-0.5* | 0.89 ±0.21y* | 2.27 ±0.61y* |
| Classification of products by processing for chemicals and no chemicals treatment | | | | | | | |
| None | | 55.38 ±2.49RS* | 3.69 ±0.04mpT* | 0.861 ±0.016q* | 4.48 ±0.82pq* | 0.61 ±0.24m* | 2.23 ±0.63T* |
| $MgCl_2$ | | 56.14 ±4.76RS* | 3.58 ±0.05mpT* | 0.867 ± 0.013q* | 4.11 ±0.37pq* | 0.69 ±0.17m* | 2.31 ±0.44T* |
| MgO | | 53.95 ±2.93RS* | 3.72 ±0.068mpT* | 0.873 ±0.060q* | 3.81 ±0.60pq* | 1.19 ±0.20m* | 3.79 ±0.44T* |
| $Ca(OH)_2$ | | 54.30 ±2.14RS* | 4.17 ±0.070mpT* | 0.875 ±0.002q* | 4.06 ±0.33pq* | 1.10 ±0.28m* | 1.88 ±0.51T* |
| $CaCl_2$ | | 53.76 ±2.45RS* | 3.65 ±0.04mpT* | 0.875 ±0.002q* | 4.52 ±0.48pq* | 0.78 ±0.29m* | 3.02 ±0.40T* |

* mean the values in a row are significantly different at the 0.05 level (2-tailed). xmpq mean the correlation of the same alphabet are significant at $p \leq 0.01$ (2-tailed). y show the correlation of the same alphabet are significant at $p \leq 0.05$. WZRST mean the correlation by regression of the same alphabet are significant at $p \leq 0.01$ (2-tailed).

All β-carotene measurements were derived using absorbency readings obtained for standard β-carotene. The standard curve for all β-carotene measurements of spectrophotometric readings was at concentrations as 0 - 0.5 mg. The calculation of β-carotene was followed by the same comparison on samples and standard solution by using a linear equation $y = 3.879x - 0.001$ at $R^2 = 0.9978$. β carotene of sample for blanching with 3 min and 5 min were orderly 0.1845-0.3332 mg/100g and 0.1125-0.2582 mg/100g. There was a statistically significant difference at $p \leq 0.01$. The water activity was used as a point of definition for the regulations of determining an acidified food. Water activity was usually controlled by changes in ingredients and the use of salt or sugar.

*3.3 Correlation between Physicochemical Characteristics and Products*

In the experiments on chili with chemical treatments were shown the effects of $Ca(OH)_2$ on change of pH. Both $MgCl_2$ and $CaCl_2$ were related to increasing content of total solid and all $Ca^{2+}$ion ($Ca(OH)_2$, $CaCl_2$) were related to a decreasing of degrees Brix.

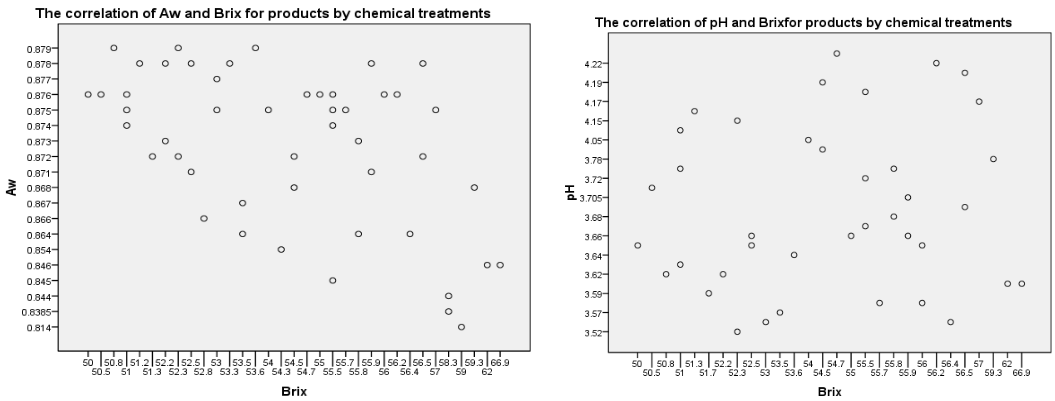


**Figure 3. The Significant Correlation of Aw & Brix and pH & Brix for Product by Chili with Chemical Treatments at the Level of $p \leq 0.01$**

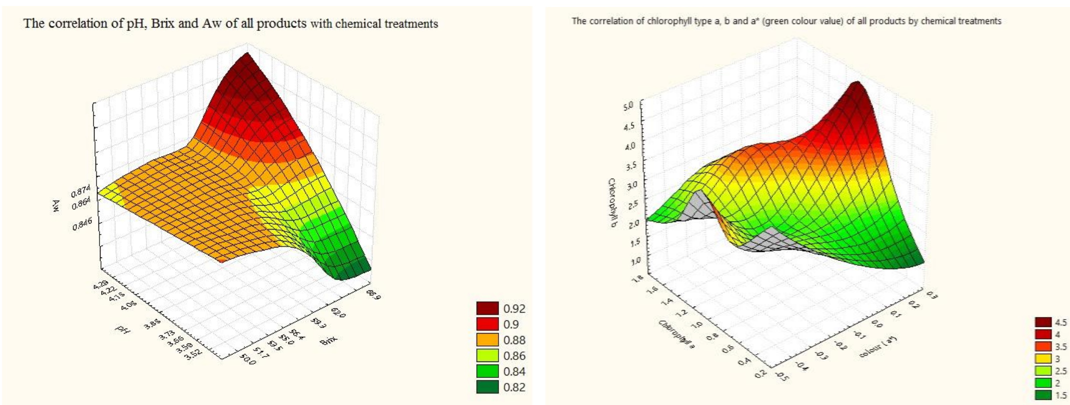


**Figure 4. Display Graph of the Correlation in Each of the Following Groups by 3D Surface Plots with Distance-weighted Least Squares of STATISTICA**

Chlorophyll (a) correlated with green colour value ( a*) and the correlation was significant at the level of $p \leq 0.01$. All products from chili with chemical treatments, Aw and pH were shown a highly significant negative correlation $R_x = 0.708$ at $p \leq 0.01$(2-tailed). The correlation of Aw and Brix were orderly negative by significant at $R_x = 0.723$ by chilies with chemical treatments and $R_x = 0.619$ at $p \leq 0.01$(2-tailed) by all chilies with none and chemical treatments. Chili with chemical treatments, the correlation pH & Wt. and pH & Brix were highly negative by significant at $R_x = 0.774$ and were highly positive by significant at $R_x = 0.768$ at $p \leq 0.01$.

## 4. Conclusion

Development and improvement of products of sea-food dipping sauce were a technique of process in product producing. Process of blanching, cooling and treatment of chemicals ($Ca^{2+}$, $Mg^{2+}$) were indicated the color enhancer. The green value of products was increased for process control on heating and cooling. A short time of chili blanching indicated to preserve a green color more. The measured values were claimed to preserve the better quality of green colour. The green colour of product was preserved in product processing on blanching and all extreme cooling.

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