Effect of Soaking Techniques and Pasteurization with and Without Acids on Some Quality Attributes of Chili Puree Prepared from Capsicum annuum Variety Kulai

To cite this article: Ermina Sari et al 2018 IOP Conf. Ser.: Earth Environ. Sci. 175 012102

View the article online for updates and enhancements.
Effect of Soaking Techniques and Pasteurization with and Without Acids on Some Quality Attributes of Chili Puree Prepared from Capsicum annuum Variety Kulai

Ermina Sari¹, Nazamid Saari², Nazimah Sheikh Abdul Hamid², Azizah Osman² and Dzulkifly Mat Hashim²

¹Universitas Lancang Kuning, Pekanbaru, 28265, Indonesia
²Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
Telp: +620761 53108, Fax: +620761 52248
Email: ermina@unilak.ac.id

Abstract: Dried chilies (Capsicum annuum Variety Kulai) were reconstituted using two different soaking techniques (cold water and boiled water soakings), crushing and stone-grinding into a fine puree and pasteurized with and without citric and acetic acids. The quality attributes of chili puree were evaluated regarding pH, moisture, Hunter surface color (L, a, b and hue angle and chroma), extractable color (ASTA units) and capsaicinoid content. Results showed that different soaking techniques had a pronounced effect on the pH, moisture content, Hunter surface color, extractable color, hue angle and chroma of the puree. However, chili puree prepared by boiled-water soaking had lower capsaicin and dihydrocapsaicin concentrations compared to cold water soaking. Pasteurization did not seem to give an effect on the Hunter surface color (L, a, and b) and pungency of the puree produced. Overall, the combined treatments of boiled water soaking and pasteurization in the presence of a mixture of 1% acetic acid (AA) and 0.2% citric acid (CA) conferred the best puree quality.

Keywords: Soaking Techniques, Pasteurization, Chilli Puree, Capsicum annuum.

1. Introduction

Chilli or scientifically known as Capsicum annuum is one of the important commercially grown peppers in the tropics. It is the most popular crop among all the capsicum cultivated species in Malaysia due to its pungency. The local and hybrids varieties of capsicum in Malaysia which are highly recommended include Kulai, MC4, MC5, MC11 and MC 12 (Anonymous, 2000). The Malaysian Ministry of Agriculture has identified Capsicum annuum variety Kulai, as the best variety for commercial production because of its pungent flavor and color. It is widely used in the manufacturing of chili paste, sauces, paste, curry mixes and pickles as well as for dressing. Despite its popularity, the variety requires proper handling and preservation to maintain its shelf-life. To ensure a constant supply of raw material for the industries and to overcome fluctuations in the price of fresh chili, production of chili puree is considered as a feasible alternative.

The puree is a common term used for processed food that has been finely mashed and pasteurized. Unlike chili bo which contains 9% ground dried chilies, 0.6% acetic acid and 5 to 10% cornstarch (Leisner et al., 1997), chili puree contains up to 90% ground dried chili.

Chilli puree quality is commonly characterized by its color and pungency (Govindarajan, 1985). Colour is considered as the main determinant factor since it is the first characteristic to be noticed by the consumers (Mcguire, 1992). The color of chili is due to the presence of red-pigmented carotenoids. The main pigments are capsanthin, capsorubin, zeaxanthin and cryptoxanthin (Lease and Lease, 1956). Commercial production of chili puree involves two major steps: grinding and pasteurization. However, when chilies are processed by grinding into a puree and pasteurized at high temperatures, the carotenoids...
easily oxidize due to heat, light, and oxygen. This leads to a more orange and less intense coloration that devalues the product. At present, the quality of chili puree in the market is not suitable as an intermediate product and starting raw material as it is sour (acidic), contains a high amount of acid and other preservatives and has an unattractive dark color. Development of a novel chili puree having a superior quality acceptable to the manufacturer is of prime importance. Therefore, the main objective of this study is to develop a suitable processing technique for the production of high-quality chili puree from *Capsicum annuum* variety Kulai by combining appropriate soaking technique and pasteurization with and without acids.

2. Materials and Methods

*Capsicum annuum* variety Kulai were obtained from the local market. The peduncle was removed from the fresh chili fruit, washed under running tap water and dried using a cabinet oven dryer for five days at 50°C.

3. Methodology

The dehydrated chili was reconstituted by soaking using two different techniques: soaked overnight at ambient temperature and soaked in boiled water (90°C) for 20 min. It was comminuted in a Waring blender and then by ground with a 150 mm diameter Corundum Grinding Stone (FE05, Taiwan) to obtain a puree of uniform size.

About 400 g of puree was weighed and packed securely in a clear plastic bag. The measurement of surface color was carried out using the Hunter Lab colorimeter (model Minolta CR-300) based on three-color coordinates, i.e., Hunter *L, a* and *b*. The *L* value signifies the lightness (100 for white and 0 for black), *a* represents greenness and redness (-80 for green and 100 for red) while *b* signifies the change from blueness to yellowness (-80 for blue and 70 for yellow). The color of puree was measured with illuminant D65. Four readings were taken for each sample.

Hue angle and Chroma were calculated from the *a* and *b* values. Chroma (C) is calculated as $\left( a^2 + b^2 \right)^{1/2}$ and represented the hypotenuse of a right triangle created by joining points (0, 0), (a, b), and (a, 0). Hue angle ($h^o$) was defined as the angle between the hypotenuse and 0° on the *a* (bluish-green/red-purple) axis; $h^o$ was calculated from the arctangent of *b/a*. Arctangent, however, assumed positive values in the first and third quadrants and negative values in the second and fourth quadrants. For a useful interpretation, $h^o$ should remain positive between 0° and 360° of the wheel (McGuire, 1992).

The extractable color was measured following the method developed by the American Spice Trade Association (1968). About 0.07-0.1 g of each sample was accurately weighed into a 100 mL stoppered volumetric flask and made up to volume with acetone. The flask was shaken rapidly for three seconds. The flask was then wrapped in aluminum foil to prevent carotenoid oxidation and left to stand for at least 16 h at room temperature. Each flask was again shaken rapidly for 3 s. The absorption of the extract was measured at 460 nm by using a UV- Visible Spectrophotometer (Shimadzu UV-1601). Absorbance data was then converted into ASTA units, which are the internationally recognized units for an extractable color of capsicum (Woodbury, 1990).

**Extractable colour (ASTA units) = Absorbance x 16.4 x I**

Sample weight (g)
where $I_f = \text{instrument correction factor (declared absorbance/actual absorbance)}$; $16.4 = \text{Conversion factor.}$

Moisture content was determined by oven drying method (AOAC, 2000). About $2 - 5 \, g$ of the puree was dried to a constant weight in crucibles at $105^\circ C$. The weight loss was equated to the moisture content of the puree. Furthermore, The measurement of pH was done according to AOAC (2000). About $10 \, g$ of puree was mixed with $40 \, mL$ of distilled water. The pH was measured in duplicates with a digital pH meter at $20^\circ C$. Then, Capsaicinoids were quantified using HPLC according to the method of Collins et al. (1995) with some modifications. Samples of $3 \, g$ each were mixed with $30 \, mL$ of acetonitrile and kept for $4 \, h$ at $80^\circ C$ with constant shaking and without reflux, before being cooled and then filtered. A Waters HPLC equipped with a Novapak C18 reversed phase column of $3.9 \times 150 \, mm$ was used. The mobile phase was methanol/water ($73:27$), and the flow rate was $1 \, mL/min$. The detector was a photodiode array, and the run was $7 \, min$ long. Capsaicin and di-hydro capsaicin were identified and quantified using standards of both compounds (Sigma; $98\%$ purity for capsaicin and $90\%$ purity for di-hydro capsaicin). A standard curve was established using serial dilutions of $100$, $200$, $400$, $600$, $800$, and $1000 \, ppm$.

The experiment was conducted as a completely randomized factorial design. The Statistical Analysis System (SAS) for windows release 6.12 was used to analyze the experimental data. Significant differences between treatments were analyzed statistically using the Duncan’s Multiple Range Test (DMRT) at $5\%$ level.

4. Results and Discussion

In this study, the effect of soaking techniques namely cold-water soaking and boiled-water soaking on some quality attributes of chili puree was determined. Dried chili was reconstituted using two different soaking techniques, comminuted using a Waring blender and then ground using a Corundum Grinding Stone (FE05, Taiwan) into the puree. The resulted puree was further pasteurized at $80^\circ C$ for $20 \, min$ either in the presence or absence of acids.

4.1 Effect of Soaking Techniques on the Hunter visual color, extractable color, Hue angle and chroma, pH, moisture and capsaicinoids content of the puree

The effect of soaking techniques on the hunter visual color, extractable color, hue angle and chroma, pH, moisture and capsaicinoids content of the puree could be seen in the following table:

Table 1. The Hunter Surface, extractable color, pungency, moisture content and pH of chili puree produced by two soaking techniques
Note: BP = Before Pasteurization; AP = After Pasteurization;
* a-c Values with the same letter within the column are not significantly different at $P < 0.05$

Table 1 shows the Hunter surface color ($L, a, b$) of chili puree prepared by different soaking techniques and pasteurized at 80°C for 20 min in the absence of acids. The results indicated that soaking techniques had a pronounced effect on the Hunter $L$ (lightness) and $a$ (redness) values of puree. Since the $L$ and $a$ values were associated with lightness and redness of color, the boiled-water soaked puree was significantly brighter than the cold-water soaked puree as indicated by higher $L$ and $a$ values. Sapers and Douglas (1987) also reported a close relationship between the Hunter $L$ and value with darkening. The lower the $L$ and $a$ values, the darker the color. Pasteurization, however, did not affect the original color of puree prepared by both soaking techniques as shown by the Hunter $L$, $a$, and $b$ values before and after pasteurization.

The Hunter $L$ and $a$ value indicated the lightness and redness on the chromaticity dimensions, however as the puree changes color during processing and heat treatment, $L$ and $b$ values change should also be included to describe the total color change (Anthonysamy et al., 2003). Therefore the $L$, $a$, and $b$ values were further evaluated regarding hue ($h^\circ$) and chroma ($C$) color to ascertain their effect on the total color change. $H^\circ$ and $C$ are an index somewhat analogous to color saturation or intensity (Hunter, 1942; Little, 1975). Hue sets the kind of color (red, yellow, blue, green, etc.) and equals the arctangent $b/a$. A sample with the hue angle of $0^\circ$ is red, $90^\circ$ is yellow, $180^\circ$ is green, and $270^\circ$ is blue. The closer the value to $90$ is, the more orange a puree will appear. Table 1 above shows the average value of hue angle and chroma of the purees. The hue angle of the purees soaked in cold-water overnight and boiled-water for 20 min, after pasteurization at 80°C for 20 min were 30.14 and 27.34, while those of chroma were 20.79 and 23.52 respectively. According to Wall (1994), a sample with a high chroma is more vivid than one with a low chroma value, even though both samples may have the same hue, while low chroma indicates a dull color, with more grays. These results showed that both techniques produced a red color puree (as the hue angle values are still in the range of red color of $0^\circ$ to $45^\circ$). The puree prepared with cold-water soaking for overnight had a dull color with more grays, while the one with boiled-water was more vivid in color. This was consistent with the previous results of $L$ and $b$ values.

The color was further evaluated regarding extractable color expressed in ASTA color unit (Govindarajan, 1985). Generally, the higher the ASTA color value, the greater the brightness or richness of the final product. There was a significant difference in the ASTA color of chili puree prepared using cold-water soaking and boiled-water soaking. The ASTA color of puree from the cold-water soaking and boiled-water soaking methods was significantly different ($P<0.05$). Boiled-water soaking showed significantly higher values than that observed for cold-water soaking. This extractable red color for boiled-water soaked puree was about 2-fold higher than the cold-water soaked puree. Capsaicin and di-hydro capsaicin together made up 80-90% of the capsaicinoids found in peppers. Effect of soaking techniques on capsaicin and di-hydro capsaicin of chili puree were compared. Boiled-water soaked chili puree had significantly lower concentrations of capsaicin and di-hydro capsaicin than cold-water soaked puree. Considerable reduction in the concentration of both pungent components for boiled-water soaked chili puree could be mainly due to solubilization of the pungency during soaking as they are sparingly soluble in water. The moisture content of chili puree prepared by both soaking techniques was noticeably different (Table 1). Boiled-water soaked chili puree had higher moisture content but was significantly less acidic than cold-water soaked chili puree.
4.2 Effect of pasteurization in the presence of acid on the color, pH, moisture and capsaicinoids content of boiled-water soaked puree.

The puree produced by soaking in boiled-water (90 °C) for 20 min was chosen for further studies as it gave the best quality chili puree regarding Hunter surface color and extractable color. Acidulants such as acetic and citric acids have been mainly used for preservation of chili puree, as both show not only strong antimicrobial activity but more importantly confer protective effects on pigment degradation (Booth and Kroll, 1989; Arnold, 1975; Russel and Gould, 1991). Thus, prior to pasteurization at 80 °C for 20 min, the purees were treated with acids in minimum quantity as follows: 1.0 % acetic acid (AA); 0.2% CA; 0.1% CA+ 1.0% AA; 0.2% CA+ 1.0% AA; 0% acid (control).

Effects of pH on color stability reported by several researchers (Holcroft and Kader, 1999; Anthonysamy et al., 2003; Rocha and Morais, 2003) revealed that lowering of pH improved the color stability than any other factor. Kearsley and Rodriguez (1981) observed that carotenoids as the red pigment in chili are relatively stable to heat at least up to 50 °C, and pH over the range between 2 and 7.

Table 2. The Hunter Surface color, extractable color, pungency, moisture content and pH of chili puree in the presence or absence of acid(s)

| Sample Identity | L value | a value | b value | Hue angle | Chroma | ASTA Unit | Pungency (ppm) | Di-hydro Capsaicin | Moisture Content (%) | pH |
|-----------------|---------|---------|---------|-----------|--------|-----------|----------------|---------------------|----------------------|-----|
| UBP             | 29.05a  | 21.30a  | 10.80a  | 27.02     | 23.88a | 224.86a   | 2.05a          | 1.96a               | 78.19                | 5.42a |
| UAP             | 29.01a  | 20.92a  | 10.76a  | 27.34     | 23.52a | 221.72a   | 2.05a          | 1.96a               | 75.31                | 5.44a |
| 1% AA           | 29.39a  | 21.36a  | 10.91a  | 27.19     | 23.98a | 206.45a   | 2.19a          | 1.94a               | 77.49                | 4.28a |
| 0.1% CA         | 29.11a  | 21.02a  | 10.78a  | 27.29     | 23.63a | 228.56a   | 2.17a          | 1.98a               | 77.11                | 5.03a |
| 0.2% CA         | 29.46a  | 21.31a  | 10.97a  | 27.37     | 23.96a | 229.02a   | 1.97a          | 1.92a               | 76.09                | 4.84a |
| 3% AA + 0.1% CA | 29.45a  | 21.09a  | 10.83a  | 27.42     | 24.04a | 220.31a   | 2.00a          | 1.93a               | 77.02                | 4.27a |
| 3% AA + 0.2% CA | 29.63a  | 21.37a  | 11.02a  | 27.31     | 23.70a | 228.59a   | 2.36a          | 1.97a               | 77.36                | 4.16a |

Note: UBP = Untreated (no acid) Before Pasteurization; UAP = Untreated After Pasteurization; AA = Acetic Acid; CA = Citric Acid

Values with the same letter within the column are not significantly different at P < 0.05.

As shown in Table 2, the effect of pH on the L, a and b values of chili puree was not significant for all samples. However, the results showed that incorporation of acids affected somewhat hue angle of the puree produced, with the highest value for puree added with 1% AA + 0.2% CA (27.42), while other treatments did not seem to effect the color. The addition of acid had a significant effect on ASTA color values. The ASTA unit was highest in the sample treated with 0.2% CA, the highest concentration of citric acid. The interaction of CA and AA gave the lowest ASTA unit as compared to the use of CA alone, but statistically, it was not significantly different (P<0.05). This could be attributed to citric acid acting both as a chelating agent and acidulant, that inhibited polyphenol oxidase (PPO) activity. PPO is a generic term for the group of enzymes that catalyze the oxidation of phenolic compounds to produce a brown color on the cut surfaces of vegetables and fruits (Whitaker and Lee, 1995).

Eshtiaghi and Knorr (1993) reported that reducing the pH of the immersion medium by addition of citric acid during high-pressure treatments could lead to increased PPO inactivation. Reliable and
promising results have been obtained using citric acid and combinations of citric-ascorbic acid and benzoic-sorbic acid as dipping treatments for minimally processed potatoes (Mattila et al., 1995). Weller et al. (1997) found that treating carambola slices with 1.0 or 2.5% citric acid and 0.25% ascorbic acid in water before packaging was very effective in limiting browning.

As shown in Table 2, acid treatments significantly ($P < 0.05$) affected the capsaicin content of chili puree, while di-hydro capsaicin content was not affected. The highest value of capsaicin was found in puree added with a combination of 1% AA and 0.2% CA.

The moisture contents of chili puree produced were in the range of 75.31 to 78.19%. The UAP had lower moisture content than the UBP. The loss of moisture in UAP during pasteurization could be due to evaporation during the heat treatment. Addition of acid increased the moisture content of the puree. The treatment with added acetic acid resulted in a higher value of moisture content in all cases. This could be due to the higher moisture content of acetic acid than citric acid.

Puree treated with added acetic and citric acid gave a lower pH value than untreated puree. The higher the concentration of acid, the lower was the pH of puree. Acids are often described as either strong (e.g., hydrochloric or phosphoric) or weak (e.g., lactic or acetic); this refers to their dissociation constant or $pK_a$ value. The $pK_a$ of an acid is the pH value at which the concentrations of its dissociated and undisassociated forms are equal. Strong acids have low $pK_a$ values, whereas weak acids have high $pK_a$ values (Brown and Booth, 1991). As the concentration of undissociated acid increased, the pH is reduced.

5. Conclusions

Data obtained from this study showed that different soaking techniques had a pronounced effect on the pH, moisture content, Hunter surface color, extractable color, hue angle and chroma of chili puree. Boiled-water soaking gave better quality puree regarding Hunter surface color and extractable color.

Acetic and citric acid at different concentrations did not influence the Hunter surface color ($L$, $a$ and $b$), hue angle and the chroma of the puree produced by boiled-water soaked chili. On the other hand, acid treatments had a significant effect on the ASTA units, pH and capsaicin content of the puree produced. Taking into consideration primarily the ASTA unit, the combined treatments of boiled water soaking and pasteurization in the presence of a mixture of 1% acetic acid (AA) and 0.2% citric acid (CA) gave the best chilli puree quality suitable as an intermediate product and starting raw material for other secondary products derived from chilli puree.

6. References

[1] American Spice Trade Association. 1968. Official analytical method of the American Spice Trade Association, 3rd ed. Method 20.1. Englewood Cliffs, New Jersey.

[2] Anonymous. 2000. The official site of the department of agricultural Malaysia. Internet: http://agrolink.moa.my/doa/dc/vege/chi_var.html

[3] Anthonysamy, S. M., Saari, N. B., Muhammad, K., Bakar, F. A. and Muse, R. 2003. Browning of sago (Metroxylon sagu) pith slurry as influenced by holding time, pH and temperature. Journal of Food Biochemistry. 28: 91-99.

[4] Arnold, M.H.M. 1975. Acidulants for food and beverages. Food Trade Press, London.

[5] Booth, I. R., and Kroll, R. G. 1989. “The preservation of food by low pH”. In: Gould, G. W. (ed). Mechanisms of Action of Food Preservation Procedures. Elsevier Applied Science, London. pp.119-160.

[6] Brown, M. H., and Booth, I. R. (1991). Food Preservative, Blackie & Son Ltd.
[7] Collin, M.D., Mayer Wasmund, L. and Bosland, P. W. 1995. Improved method for quantifying Capsaicinoids in Capsicum using High-Performance Liquid Chromatography. *Hort. Science*. 30:137-139.

[8] Eshtiaighi, M. N. and Knorr D. 1993. Potato cubes response to water blanching and high hydrostatic pressure. *Journal of Food Science*. 58: 1371-1374.

[9] Govindarajan, V. S. 1985. *Capsicum* - Production, technology, chemistry, and quality. Part 1: History, botany, cultivation, and primary processing. *CRC Critical Reviews in Food Science & Nutrition*. 22:109-176.

[10] Holcroft, D. M., and Kader, A. A. 1999. Controlled atmosphere-induces changes in pH and organic acid metabolism may affect the color of the stored strawberry fruit. *Postharvest Biology and Technology*. 17: 19-32.

[11] Hunter, R.S. 1942. *Photoelectric tristimulus colorimetry with three filters*. NBS Circ. C 249, U.S. Dept. Commerce, Washington, D.C.

[12] Lease, J. G., and Lease, E. J. 1956. Factors affecting the retention of red color in peppers. *Food Technology*. 10: 368-373.

[13] Leisner, J. J., Rusul, G., Wee, B. W., Boo, H. C., and Kharidah, M. 1997. Microbiology of chili bo, A popular Malaysian food ingredient. *Journal of Food Prot.* 61(10): 1235-1240.

[14] Little, A.C. 1975. Off on a tangent. *Journal of Food Science*. 40:410-411.

[15] Mattila, M., Ahvenainen, R., Hurme, E. 1995. Prevention of browning of pre-peeled potato. *In*: Laurila, E., Kervinen, R., and Ahvenainen, R. 1998. The inhibition of enzymatic browning in minimally processed vegetables and fruits. *Postharvest News and Information* Vol. 9 No. 4 53N–66N

[16] McGuire, R.G. 1992. Reporting of objective color measurements. *Hort. Science*. 27(12) : 1254-1255.

[17] Rocha, T., Lebert, A. and Marty-Audouin, C. 1993. Effects of pre-treatments and drying conditions on drying rate and color retention of basil. *Lebensmittel-Wissenschaft und-Technology*. 26: 456-463.

[18] Russell, N. J., and Gould, G.W. 1991. *Food Preservatives*. Blackie and Son Ltd., London.

[19] Wall, M. M. 1994. *Colour analyses for dehydrated Capsicums*. Cooperative Extension Service (Circular 546), Las Cruces.

[20] Weller, A., Sims, C. A., Matthews R. F., Bates R. P., Brecht J. K. 1997 Browning susceptibility and changes in composition during storage of carambola slices. *Journal of Food Science*. 62:256-260

[21] Whitaker, J. R., and Lee, C. Y. 1995. Recent advances in the chemistry of enzymatic browning: An overview. *In*: C.Y. Lee and J. R. Whitaker. Eds., Enzymatic Browning and Its Prevention. Washington, ACS Symp. Ser 600, pp 2-7.

[22] Woodbury, J.E. 1990. *Spices and other condiments*. *In*: Official methods of analysis of the association of official analytical chemists. Helrich, K. (ed.). 15th ed. Arlington, Virginia: 999-1001.