CHAPTER 3

Materials and Methods

3.1 Phase 1: Formulation of the optimum osmotic solution for drying intermediate moisture longan

3.1.1 Formulation of the optimum osmotic solution for intermediate moisture longan

Preparation of IML: The longan fruits (Thongpoon Food Limited Partnership, Lamphun, Thailand) were cleaned, seed removed and peeled. Two type of osmotic solution contained (1) 40% glycerol: sucrose solution (GS) at the ratio 1: 1 and (2) 40% sucrose: glycerol: sorbitol solution (SGS) at the ratio 2: 1: 1. Then 1% acid citric and 0.1% potassium sorbate were added in these mixture solutions. The commercial longan (dried longan of Thongpoon Brand) was used as a control. Treated longan which was immersed for 12 hours (Gudapaty *et al.*, 2010) at air – condition temperature (25^{o}C) were dried in the hot air oven at 60^{o}C.

The drying curves were applied to identify the drying time for each formulation for drying of IML at 60^{o}C. The qualities of IML samples from 2 different formulations were investigated on physicochemical properties and sensory evaluation as described in 3.5, 3.6 and 3.7.

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3.1.2 Study on osmotic dehydration conditions for production of intermediate moisture longan

Preparation of IML: The longan arils were prepared familiar with the previous stage. After draining water out of flesh longan, they were immersed in the osmotic

solution which the formulation picked out from the earlier experiment for 6, 12 and 18 hours within different temperature conditions following ambient, air – conditioner (25^{o}C) and in refrigerator (4^{o}C). And then they were dried in the hot air oven at 60^{o}C for the drying time which was pointed out from prior stage (8 hours).

To evaluate the influence of osmotic dehydration conditions on water loss (WL), solids gain (SG), and the mass variation (MV) was determined for each time and condition of the osmotic treatment. Thus these parameters were calculated according to (Keila *et al.*, 2014). The qualities of IML samples from 3 different conditions of osmotic dehydration were investigated on physicochemical properties and sensory evaluation as described in 3.5, 3.6 and 3.7.

3.2 Phase 2: Comparison of the effects of hot air drying and vacuum oven drying on the quality of intermediate moisture longan

Preparation of IML: The longan fruits (Thongpoon Food Limited Partnership, Lamphun, Thailand) were cleaned, seed removed and peeled. The fruits were then immersed in osmotic solution which included sugar solution from 3.1, potassium sorbate (0.1%) and citric acid (1%) for 12 hours at the air – conditioner room (24^{o}C) from 3.1. The fruits were then taken out of the osmotic solution, drained for 15 min. Then they were dried as followed (1) hot air oven at 60^{o}C, 70^{o}C and air velocity of 0.5 m/s and (2) vacuum oven at 60^{o}C, 70^{o}C to bring the water activity to 0.6.

The drying kinetics were applied to identify the drying time for each formulation for drying of IML at 60^{o}C and 70^{o}C of two drying methods. The qualities of IML samples were investigated on physicochemical properties and sensory evaluation as described in 3.5, 3.6 and 3.7.

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3.3 Phase 3: Determination of the qualities of intermediate moisture longan product using fresh longan compare with frozen longan

Preparation of IML: The longan fruits (Thongpoon Food Limited Partnership, Lamphun, Thailand) were prepared as same as 3.1. It were immersed in the osmotic solution which the formulation was identified from the preceding experiment. The fleshes

were packed and stored in freezer (- 20°C). They were thawed in microwave oven before drying (240W for 2 min). At that time, the longan sample including from fresh and frozen materials were drained and dried in the hot air oven at 60°C (for 8 hours).

The drying curves were applied to identify the drying time for each treatment for drying of IML at 60°C. The qualities of IML samples were analyzed as described in 3.5, 3.6 and 3.7.

3.4 Shelf – life evaluation of intermediate moisture longan

Preparation of IML: The longan fruits (Thongpoon Food Limited Partnership, Lamphun, Thailand) were cleaned, seed removed and peeled. The fruits were then immersed in osmotic solution which included sugar solution from 3.1, potassium sorbate (0.1%) and citric acid (1%) for 12 hours at the air – conditioner room (24°C) from 3.1. The fruits were then taken out of the osmotic solution, drained for 15 min and dried in the hot air oven at 60°C and air velocity of 0.5 m/s for 8 hours to bring the water activity to 0.6. The intermediate moisture longan products were then kept in 3 different kinds of package which are aluminum foil laminated with plastic bag packed with nitrogen (Al bag with nitrogen), aluminum foil laminated with plastic bag packed without nitrogen (Al bag without nitrogen) and clear plastic bag (polyamide). They were stored at the different temperatures (4°C, 25°C, 35°C and 45°C) during 6 months.

The qualities of IML samples were analyzed as described in 3.5, 3.6, 3.7 and 3.8.

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3.5 Physicochemical properties

Water activity (a_w) and moisture content (MC) were analyzed by Water activity analyzer (Decagon, USA) and AOAC (2000) by a vacuum oven at 70°C, respectively. A colorimeter (Konica Minolta Chroma Meter, CR-410, Japan) was used to measure the color parameters of the samples expressing as L*, a*, b* parameters.

The hardness was obtained by penetration test using Texture Analyzer model TA – XT2i (Texture Technologies, Inc., UK). The penetration probe of 2 mm in diameter was applied. The pre – test speed were set 1 mm/ s with the distance of 15 mm/s and

acquisition rate of 400 points/ s. The measurement was determined in 10 replications for each sample.

Figure 3.1 Textural analysis

3.6 Antioxidant capacity

Radical scavenging activity of the sample extracts was measured by determining the inhibition rate of DPPH (2, 2 – diphenyl – 1 – picrylhydrazyl) radical (Axelle *et al.*, 2016). In the method, 140 µl of extracts was added to 2.8 ml DPPH radical ethanoic solution (10^{-4}M). The control sample prepared was to separate the flesh longan from whole longan fruit and then ground after drying in hot air oven at 55 ± 0.5°C for 12 hours (Huang *et al.*, 2012). The powder (10g) was extracted with water (100 ml) at 100°C for 60 min and then filtered with the filter papers. The absorbance at 517 nm was measured by using a UV – vis Spectrophotometer (Cecil Aquarius). The results were expressed in terms of radical scavenging activity.

DPPH inhibition (%) = $[(A_o - A_s)/A_o] \times 100$

(**Source**: Axelle *et al.*, 2016)

Where A_o is absorbance of control blank, and A_s is absorbance of sample extract.

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3.7 Microbial analysis

The every microbiological load analyzed in this research: total bacterial count (TBC), yeast and mold count (YMC), *Escherichia coli* at day 0 was determined as described by AOAC (2012). Individual longan samples were aseptically homogenized for 1 min in stomacher bags with 90 ml peptone water (0.1%) using Stomacher Blender. Serial dilutions were made in 9 ml peptone water (0.1%) and pour plate in duplicate. Media employed were Plate Count Agar (PCA), Potato Dextrose Agar (PDA), Lactose Broth (LSB) and Brilliant Green Lactose Bile Broth (BLGBB) for determination of TBC, YMC and *E. coli*, respectively. The microbial analyses of intermediate moisture longan samples were undertaken periodically during storage.

3.8 Accelerated shelf life testing procedure and kinetics calculations

To determine the reaction order, zero and first order equations were applied separately and the values obtained for the color, texture and acceptance scores of color were plotted as a function of storage time. Considering statistical analysis, R^2 was found in color, texture and acceptance scores of color values following zero and first order trends. Thus, the linear regression was carried out for these values, corresponding to the values of *k* (reaction velocity) by zero (Eq. 3.1) and first (Eq. 3.2) order equation for each temperature (Man and Jones, 1994).

$$Q = Q_o - kt \quad \text{(Eq. 3.1)}$$

$$ln\ \frac{Q}{Q_o} = -kt \quad \text{(Eq. 3.2)}$$

Where Q_o represents some initial value of a quality attribute and Q is the amount of that attribute left after time *t*.

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Temperature dependence of color, texture and acceptance scores of color reaction was simulated by Arrhenius equation (Eq. 3.3)

$$\ln k = \ln A - \frac{E_a}{RT} \quad \text{(Eq. 3.3)}$$

Where E_a, R, T and A are activation energy of each reaction (J/mol), universal gas constant (8.314 J/mol.K), absolute temperature (K), and pre – exponential factor, respectively.

As the quality parameters followed zero or first order reaction, Eq. 3.4 and Eq. 3.5 were used to predict the time which is needed for changes happening in color and acceptance scores of color indices (Man and Jones, 1994).

$$t_s = \frac{Q_o - Q_e}{k} \quad \text{(Eq. 3.4)}$$

$$t_s = \frac{ln\frac{Q_o}{Q_e}}{k} \quad \text{(Eq. 3.5)}$$

Where t_s is the time predicted to incur these changes.

3.9 Sensory evaluation

Sensory evaluation was carried out using 100 panelists (excepted for shelf life evaluation, 50 panelists were used). The consumer acceptance test was applied using a 9 – point hedonic scale (9 = "like extremely", 5 = "neither like nor dislike", 1= "dislike extremely"). Sensory attributes considered were overall acceptability, color, odor, taste and texture (excepted for shelf life evaluation, overall acceptability, color, odor were investigated). Samples consisted of 10g of dried longan and were identified using a 3 – digit random number.

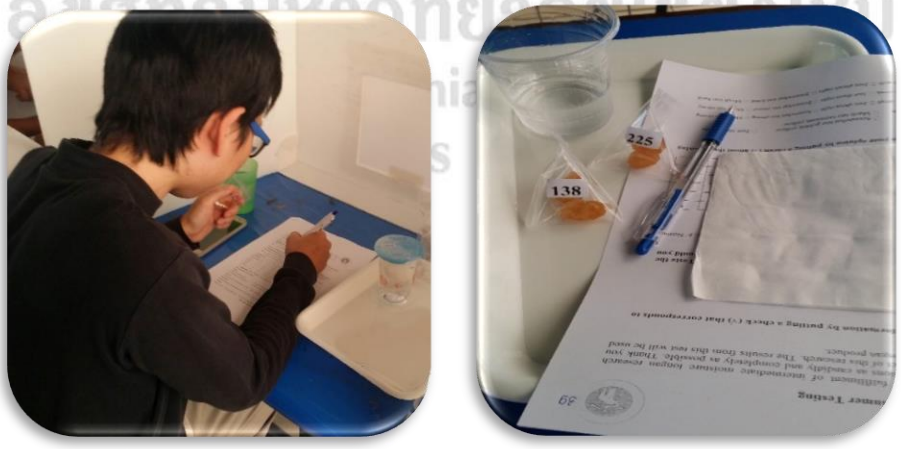

Figure 3.2 Sensory evaluation testing

3.10 Statistical analysis

A Completely Randomized Design (CRD) experiment with 2 replications was conducted in this study (excepted in experiment 3.2 and 3.4, a factorial design experiment in CRD was used). Analysis of variance (ANOVA) was carried out by using the SPSS version 16.0 and the determination of significant differences among the treatment means was done by Duncan's multiple range test ($p \leq 0.05$).

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