

Effect of Room Temperature Storage on the Physicochemical and Antioxidant Properties of Oven Dried Young Tamarind Leaves (*Tamarindus Indica*) Chutney Powder

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Abstract

Objectives: To study the effect of room temperature storage on the antioxidant properties of young tamarind leaves chutney powder. **Methods:** Instant young tamarind leaf chutney powder was developed with oven dried young tamarind leaves along with mixture of spices at various ratios for their storage stabilities and antioxidant activities for 12 d at room temperature (27 °C) storage. DPPH, ABTS and FRAP were studied. **Findings:** The addition of oven dried young tamarind leaves significantly increases the moisture, ash, protein, fat and fiber content at 0 d of TLCP ($P<0.05$). Increasing tamarind leaf concentrations significantly lowers L values and increases a and b values of T1 and T2, irrespective of its storage times ($p<0.05$). Similarly, total polyphenol content increases significantly with higher addition of tamarind leaves in TLCP at T2 ($p<0.05$). This was highly correlated with increased DPPH, ABTS and FRAP of TLCP at T2 during 0 d storage. However, slight decrease in the antioxidant activities of TLCP during 12 d storage. **Applications/Improvements:** In overall, oven dried TLCP can be used as a functional instant chutney powder and can be stored at room temperature without much alteration in their functional effects.

Keywords: ABTS, Chutney Powder, DPPH, Oven Dried Tamarind Leaves, Total Polyphenol

1. Introduction

Health beneficial foods or functional foods rich in various phyto compounds are in great demand among the developing and developed countries around the world^{1,2}. This in turn leads to the search of new products development from the underutilized plant foods³. Among those underutilized plant foods, tamarind (*Tamarindus indica*L.), young leaves usage was not well studied. These leaves are used mostly among the hill tribal people or in the village areas of India and Africa for their enhanced health effects⁴⁻⁶. These young leaves are rich in various phyto compounds such as phenolic compounds, cardiac glycosides, L-(-)mallic acid, tartaric acid, the mucic

lage and pectin, arabinose, xylose, galactose, glucose, and uronic acid which shows multifunctional activities includes antidiabetic, antimalarial, anticardiovascular and antivenom activities^{7,8}. Traditional usages of these young leaves also varies with countries⁹⁻¹¹. In India, it is used as a seasoning ingredients in various dishes among the south Indians. In Phillipines it is used for the treating malarial infection as herbal tea. In Thailand, the leaves are used as an ingredients in salads for their greater medicinal benefits¹². However, the usage of the young leaves as an ingredient in the chutney powder is yet to be studied.

Chutney powder is a staple food commonly consumed among the Indians¹³⁻¹⁵ as a ready to eat food without refrigerated storage for maximum up to twelve days.

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Literature review suggests that various food ingredients are used in the development of chutney powder based on their seasonal availability of those products. For example, flax seeds, mangoes, curry leaves are used for their studies in the development of the chutney powder¹³⁻¹⁵. However, there was no studies in related to physicochemical and antioxidant properties of the young tamarind leaves chutney powder during the room temperature storage. Therefore, our studies was focussed on the development of young tamarind leaves chutney powder and to analyse their physicochemical and antioxidant properties during the room temperature storage.

2. Materials and Methods

2.1 Material

Tamarind young leaves (*Tamarindus indica L.*) having no visible damage, colour change or spots, spices such as bengal gram, chillies, cumins, coriander seeds and black gram was purchased from the local market in Seri kembangan, Selangor, Malaysia. Tamarind young leaves were sorted manually and the young leaves without sticks was washed with water in a ratio of 1:3 (w/v). Then the leaves were evenly spread on tray and oven dried at 40 °C for 3 d.

2.2 Chemicals and Reagents

2,2'-azino-bis-3-ethylbenzthiazoline-6-sulphonic acid (ABTS) powder, 6-hydroxy-2, 5, 7, 8- tetramethylchroman-2-carboxylic acid (Trolox), potassium persulfate, gallic acid, folin Ciocalteu's phenol reagent, 2,2-Diphenyl-1-picrylhydrazyl (DPPH), was purchased from Sigma-Aldrich (Germany). All other solvents were of analytical grade.

2.3 Preparation of Instant Young Tamarind Leaves Chutney Powder

Oven dried young tamarind leaves (190 g) were ground to pass through BS No. 30 mesh sieve (500 p). Different ingredients black gram (40 g), bengal gram (40 g), coriander seeds (40 g), cumin (10 g), red chilies (20 g) and sesame oil (10 g) were individually roasted on an open pan until characteristic aroma developed, and ground to pass through BS No. 30 mesh sieve (500 p). The spice mix was prepared from roasted and ground spices and pulses. Fresh young tamarind leaves powders were mixed with a

spice mix at 1: 1 and 1:2 ratios using a blender, which will pass through BS sieve mesh No. 30. Then it was labelled as T1 and T2. The three sample (Control, T1 and T2) were stored at room temperature of 27°C.

2.4 Chemical Analysis

The chemical composition of TLCP such as moisture, ash, protein, and fat contents of chutney powder added with and without oven dried tamarind young leaves were determined by AOAC methods¹⁶ with slight modifications.

2.5 pH

The pH of TLCP added with and without oven dried young tamarind leaves was measured in a suspension resulting from blending 10 g sample with 10 mL of deionized water for 2 min, using a pH meter (Orion 900A, Boston, MA, USA).

2.6 Volume and Bulk Density

The volume and bulk density of TLCP added with or without oven dried young tamarind leaves according to previous method¹⁷ with slight modifications. 2 g of TLCP was taken into a 10-mL measuring cylinder, and then holding the cylinder on a vortex vibrator for 1 min to obtain a constant volume of the sample. The volume of the sample was recorded against the scale on the cylinder. The bulk density value of TLCP was calculated as the ratio of mass of the powder and the volume occupied in the cylinder. This analysis were repeated for various storage times.

2.7 Color

The colour values of TLCP added with and without oven dried young tamarind leaves was studied in the colorimeter (Minolta Camera Co., Osaka, Japan). Lightness (L^*), red/green (a^*), yellow/blue (b^*) of TLCP were studied at different storage times.

2.8 Solubility

The solubility of TLCP added with or without oven dried young tamarind leaves were evaluated according to previous method¹⁷ with slight modifications. Briefly, TLCP (0.5 g) added with or without oven dried young tamarind leaves were suspended in 30 mL of distilled water and heated in a shaking water bath at 80 °C for 60 min.

After heating, all samples were centrifuged at 1500 g for 30 min, and precipitates were separated from supernatant and weighed. The supernatant was dried at 60 °C for 24 h and weighed. Then, the solubility of TLCP added with or without oven dried young tamarind leaves were calculated using the following equation. Solubility = 100 x Mass of supernatant (dry basis) / Mass of sample (dry basis).

2.9 Swelling Power and Angle of Repose

The swelling power and angle of response of TLCP added with or without oven dried young tamarind leaves were measured at various storage times according to previous method¹⁸ with slight modifications. The swelling power of TLCP samples were calculated using

Swelling Power = 100/ Mass of sample (dry basis) x (100- Solubility) x Mass of precipitates

The angle of repose (α) of TLCP was calculated as the following formulae: $\alpha = \arctg(2H/R)$.

2.10 Water-Holding Capacity (WHC) and Oil-Holding Capacity (OHC)

The WHC and OHC of TLCP added with or without oven dried young tamarind leaves were determined according to previous method¹⁹ with slight modifications. TLCP (2g) added with or without oven dried young tamarind leaves were mixed with 25 mL of distilled water in pre-weighed centrifuge tubes, centrifuged (25 min X 3,000 g) and discarded the supernatant. The WHC of TLCP added with or without oven dried young tamarind leaves were determined at different storage times and expressed as gram of water retained per gram of sample.

For oil-holding capacity, the TLCP (2g) added with or without oven dried young tamarind leaves (2 g) were mixed with 30 mL of extra virgin oil in pre-weighed centrifuge tubes. Then, the dispersions were stirred and left at 25 °C for 1 h, centrifuged (25 min X 3000 g) and oil supernatant discarded. The OHC of TLCP added with or without oven dried young tamarind leaves were expressed as grams of oil retained per gram of sample during storage times

2.11 Total Phenolic Contents (TPC)

The TPC of of TLCP added with or without oven dried young tamarind leaves were determined using Folin Ciocolteau method using gallic acid standard curve. The results were expressed as Gallic acid equivalents (GE) mM/g of TLCP during various storage times

2.12 DPPH Radical Scavenging Activity

The DPPH radical scavenging activities of TLCP added with or without oven dried young tamarind leaves were done according to previous method²⁰ with slight modifications. The radical scavenging activity of TLCP added with or without oven dried young tamarind leaves at different storage time were calculated using the following equation

Radical scavenging activity (%) = [(Asample / A reagent blank)] x 100

2.13 ABTS

The ABTS radical scavenging activity of TLCP added with or without oven dried young tamarind leaves at different storage times was done according to previous method²¹ with slight modifications. The results were expressed as the trolox equivalent antioxidant capacity (TEAC), which defined as mM of Trolox per 100 gram of TLCP added with or without oven dried young tamarind leaves at different storage times.

2.14 FRAP assay

FRAP of TLCP added with or without oven dried young tamarind leaves at different storage times was performed according to previous method²² with slight modifications. The FRAP value was expressed in mM of ferrous sulfate per 100g of TLCP added with or without oven dried young tamarind leaves at different storage times.

2.15 Statistical Analysis

All measurements were performed in triplicate. The results were statistically analyzed by using minitab statistical software, version 16 and expressed as mean \pm SD. Analysis of variance (ANOVA) and mean corresponding to length of extraction time and type of solvents were compared by using Turkey test.

3. Results and Discussion

3.1 Changes in Chemical Composition of Oven Dried Young Tamarind Leaves during Room Temperature Storage

Changes in chemical composition of TLCP added without and with oven dried young tamarind leaves at different concentrations (T1 and T2) stored at room tem-

perature for 12 d are shown in Figure 1. The addition of oven dried young tamarind leaves significantly increases the moisture, ash, protein, fat and fiber content at 0 d of TLCP ($P < 0.05$). The chemical composition of leaves^{23, 24} contributes to the increase in chemical composition concentration of TLCP. Further increasing the storage period of TLCP to 12 d, the moisture content tend to be significantly increased irrespective of concentrations of tamarind leaves added to TLCP ($P < 0.05$). However, ash content showed significantly no difference between the TLCP added with or without tamarind leaves during storage of 12 d ($P > 0.05$). Protein and fat content of TLCP showed significantly lower content during 12 d storage irrespective of concentrations of tamarind leaves added to the TLCP. This was most likely due to the protein and fat degradation during room temperature storage. Similarly, fiber content of TLCP also found to be lower during the 12 d storage irrespective of the concentrations of tamarind leaves added to the TLCP. From this analysis, it confirms that lower the room temperature storage period lower the loss of chemical compositions irrespective of the concentrations of tamarind leaves added to the TLCP.

3.2 Changes in pH, Volume and Bulk Density of Oven Dried Young Tamarind Leaves Chutney Powder during Room Temperature Storage

Changes in pH, volume and bulk density of TLCP added without or with oven dried young tamarind leaves at different concentrations (T1 and T2) stored at room temperature for 12 d are shown in Figure 2. Increasing the concentrations of tamarind leaves addition, significantly increases the pH of chutney powder at 0 d storage ($P < 0.05$). This was most likely due the presence of various acidic bioactive compounds in the tamarinds leaves²⁵. However, increasing the storage period to the 12 d significantly lowers the pH values, irrespective of the treatments. The volume of the chutney powder was significantly higher at the TLCP added with higher concentrations of tamarind leaves (T2). The higher the concentration of particles greater the volume of the food powders. Similarly,¹⁸ also reported that greater the concentrations of particles greater the volume of the food powders. However, increasing the storage time to 12 d slightly lowers the volume of the chutney powder, irrespective of the treatments. The bulk density of the TLCP was significantly reduced with higher concentrations of

the tamarind leaves added to the chutney powders at 0 d storage. The addition of tamarind leaves alters the cohesion of the food powders which results in the lower bulk density values of the chutney powders. Increasing the storage periods to 12 d was significantly lower the bulk density value of the chutney powders, irrespective of the tamarind leaves added to the TLCP. This concluded that increasing room storage period can result in lower bulk density value of the TLCP, irrespective of the addition of oven dried young tamarind leaves.

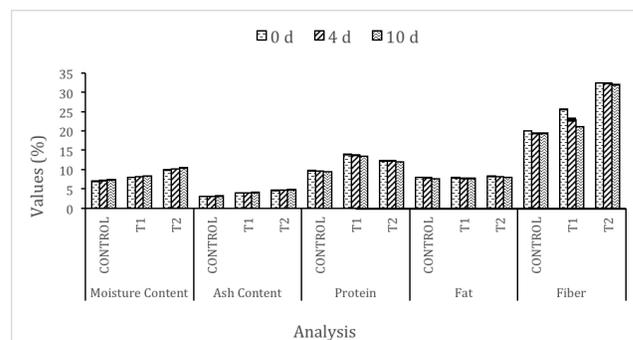


Figure 1. Proximate analysis of tamarind leaves chutney powder added with different concentrations of oven dried young tamarind leaves during room temperature storage. (Control : Spices ; T1 : Tamarind leaves and spices of 1:1 ratio and T2 : Tamarind leaves and spices of 2:1 ratio).

3.3 Changes in Color, Solubility, Swelling Power and Angle of Response of Oven Dried Young Tamarind Leaves during Room Temperature Storage

Changes in color, solubility, swelling power and angle of repose of chutney powder added without or with young tamarind leaves at different concentrations (T1 and T2) stored at room temperature for 12 d are shown in Figure 3 and 4. L values significantly reduced for the TLCP added with oven dried young tamarind leaves, irrespective of the concentrations at 0 d storage ($P < 0.05$). Further, increasing the storage period to the 12 d there was no difference among the L values of the chutney powder, irrespective of the treatments. Similar trends also observed for the a and b values of the samples, irrespective of treatments for 0 d and during the storage period of 12 d. However, increasing concentration of the tamarind leaves significantly reduce the a and b value, without affecting the L value, this was most likely due to the color pigments of the tamarind leaves. The solubility of the chutney powder was significantly increased for T1 and T2, irrespective of the

storage times up to 12 d. This was most likely due to the soluble compounds present in the tamarind leaves which enhances the solubility of the TLCP at various concentrations. However, there was slight reduction in the solubility of the TLCP during storage of 12 d. It was mostly due to the effect of the room temperature storage and the loss of soluble particles^{26,27}. The swelling power of the chutney powders alters with young tamarind leaves addition at 0 to 12 d. The swelling power alters most likely due to the breaking of starch and leaching out of glucose, higher the breaking of starch molecules greater the solubility^{26,28}. The angle of repose of chutney powder was significantly higher in the control than T1 and T2 ($P < 0.05$). This was most likely due to the higher cohesive force between the powders during storage periods. Higher the cohesive force greater the angle of repose among the powders. Greater the addition of the tamarind leaves (T2) lowers the cohesive force and lowers the angle of repose of the chutney powder. However, increasing the storage period of 12 d does not change the value of angle of repose of TLCP irrespective of tamarind leaves during room temperature storage.

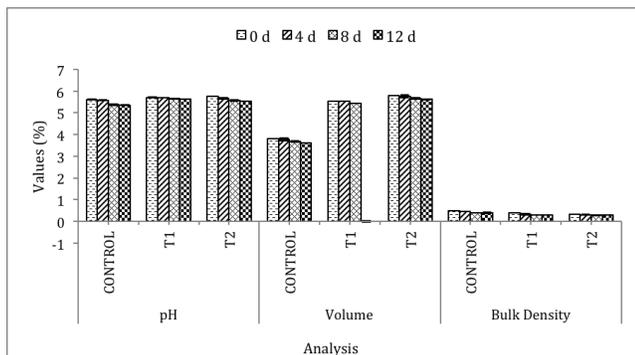


Figure 2. pH, volume and bulk density of tamarind leaves chutney powder added with different concentrations of oven dried young tamarind leaves during room temperature storage (Control : Spices ; T1 : Tamarind leaves and spices of 1:1 ratio and T2 : Tamarind leaves and spices of 2:1 ratio).

3.4 Changes in Water and Oil Holding Capacity of Oven Dried Young Tamarind Leaves during Room Temperature Storage

Changes in water and oil holding capacity of TLCP added without or with oven dried young tamarind leaves at different concentrations (T1 and T2) stored at room temperature for 12 d are shown in Figure 5. Water and oil holding capacity of TLCP significantly increases with increase concentration of tamarind leaves addition (T1

and T2) during 0 d and increased upto 12 d. Higher the addition of tamarind leaves higher the addition of hydrophilic and hydrophobic compounds to the TLCP. Further, higher oil holding capacity in T1 and T2 may related the insoluble fibre present in the tamarind leaves. This results in the greater increase of the oil holding capacity of the chutney powders irrespective of the concentrations added. However, increasing storage d to 12 d significantly loses the water and oil holding capacity values. This was most likely due to the room temperature storage of the TLCP may result in the loss of some soluble compounds. The loss of polysaccharides compounds during oven drying and increasing temperature also reported in certain food ingredients like apple pomace^{29,30}. It was highly correlated with the solubility of the chutney powder during room temperature storage of 12 d.

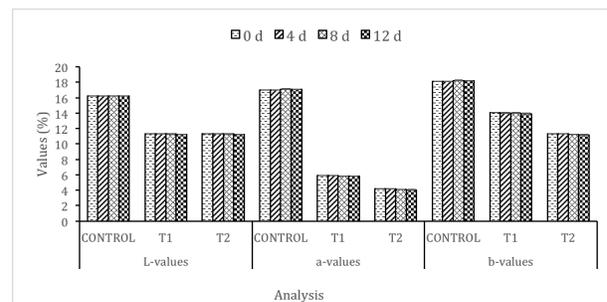


Figure 3. Colour value of tamarind leaves chutney powder added with different concentrations of oven dried young tamarind leaves during room temperature storage (Control : Spices ; T1 : Tamarind leaves and spices of 1:1 ratio and T2 : Tamarind leaves and spices of 2:1 ratio).

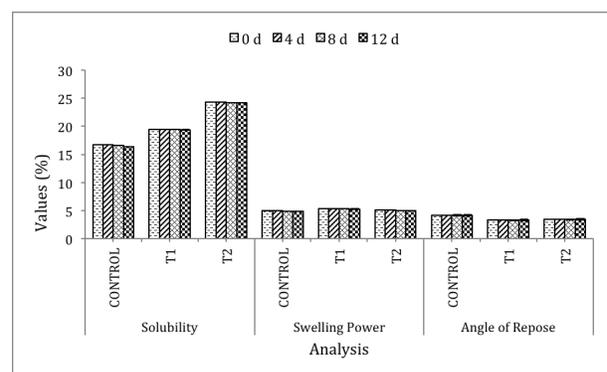


Figure 4. Solubility, swelling power and angle of repose of tamarind leaves chutney powder added with different concentrations of oven dried young tamarind leaves during room temperature storage. (Control : Spices ; T1 : Tamarind leaves and spices of 1:1 ratio and T2 : Tamarind leaves and spices of 2:1 ratio).

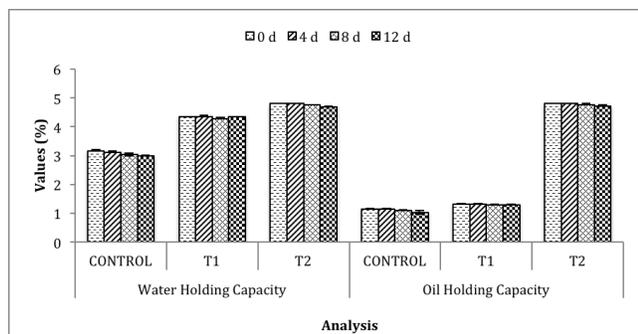


Figure 5. Water and oil holding capacity of tamarind leaves chutney powder added with different concentrations of oven dried young tamarind leaves during room temperature storage. (Control : Spices ; T1 : Tamarind leaves and spices of 1:1 ratio and T2 : Tamarind leaves and spices of 2:1 ratio).

3.5 Changes in Total Polyphenol and Free Radical Scavenging Activity of Oven Dried Young Tamarind Leaves during Room Temperature Storage

Changes in total polyphenol content and free radical scavenging activity of TLCP added without or with young tamarind leaves at different concentrations (T1 and T2) stored at room temperature for 12 d are shown in Figure 6. The higher the addition of tamarind leaves (T1 and T2) the greater the value of the TPC of the TLCP. This confirmed that higher the polyphenol content of tamarind leaves contributes the total polyphenol content of the chutney powder. Tamarind leaves are rich in polyphenol such as catechin, tartaric acid and epicatechin may leads to the higher polyphenol content³¹⁻³³ of those chutney powders . However, increasing the storage period of 12 d leads to the slightly lower total polyphenol content of the chutney powders, irrespective of the concentrations added. Oven drying and room temperature storage can causes subsequent loss of bioactive compounds. DPPH free radical scavenging activity of the TLCP at 0 d storage showed significantly higher for T2 and T1 followed by the control at 0 d storage. This was most likely due to the higher polyphenolic content of the tamarind leaves. Similarly, some researchers also reported that higher polyphenolic content leads to the higher antioxidant activity³⁴⁻³⁷. However, increasing the storage period to 12 d showed slightly lower free radical scavenging activity. Higher room temperature exposure of the polyphenolic compounds may leads to the structural changes and the loss of activity of TLCP. Similarly, various other powders also reported that increase the temperature may lead

to the structural loss of the polyphenolic compounds³⁸. FRAP and ABTS radical scavenging activity of the TLCP followed the same trend of DPPH radical scavenging activity of the chutney powders during room temperature storage of the 12 d. From this study we concluded that higher the addition of tamarind young leaves greater the TPC and antioxidant activity of the chutney powder during room temperature storage of 12 d.

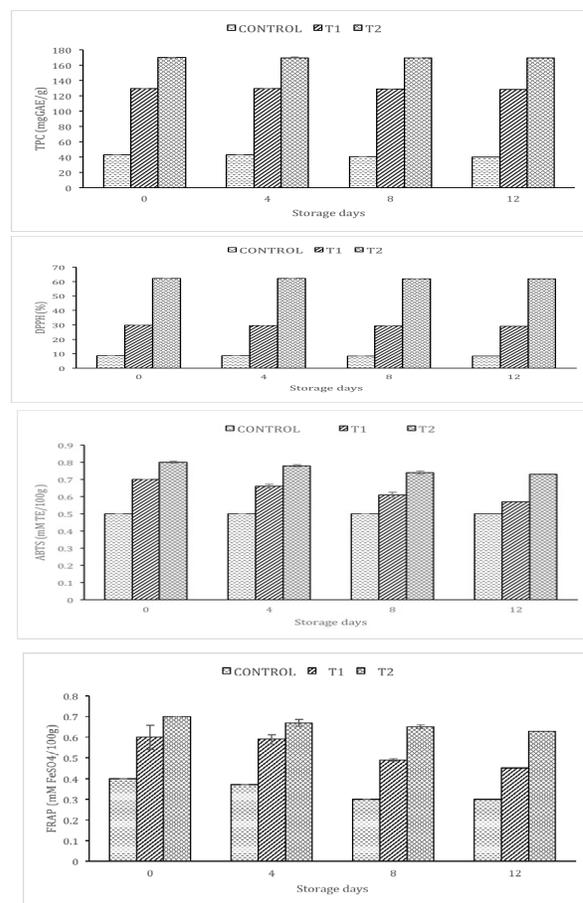


Figure 6. Total polyphenol content, DPPH, ABTS and FRAP of tamarind leaves chutney powder added with different concentrations of oven dried young tamarind leaves during room temperature storage. (A: Total polyphenol content, B: DPPH, C: ABTS, D: FRAP, Control : Spices ; T1 : Tamarind leaves and spices of 1:1 ratio and T2 : Tamarind leaves and spices of 2:1 ratio).

4. Conclusion

This study confirmed that oven-dried young tamarind leaves can be used for the preparation of instant chutney powder and it can be stored at room temperature without much alteration in the physicochemical and functional

properties. This study confirmed that underutilized plant leaves can be used for the development of functional food with enhanced health benefit and in near future it can be marketed.

5. Acknowledgement

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6. References

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