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Changes in Colour attributes of Kithul (*Caryota urens*) flour stored in Refrigerated (4°c) Condition

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Abstract: Colour of the food is the first consideration for quality evaluated by consumers. This paper is aimed to evaluate the colour as to define criteria for differentiation of fresh and one year old flour samples. Kithul flour (*Caryota urens*) colour were evaluated in terms of lightness (L*) value , redness(a*) value ,yellowness (b*) values as well as the total colour difference(ΔE). Kithul flour samples which were collected from five main growing areas presented significant difference ($p < 0.05$) among their colour attributes during shelf life which was stored in refrigerated condition (4°C). According to the instrumental measurements, lightness value has significantly changed ($P<0.05$) by improving after one year time period. Nevertheless redness and yellowness value has not significantly changed after one year time period. However redness has improved while yellowness has decreased with the time .According to the colour attributes of flour samples Matale (ΔE=34.77) and Kegalle (ΔE=34.65) had a greater deviation from the standard colour value than the other samples. Kandy area presented the least deviation from standard as ΔE=30.24 at the initial stage. With the time colour difference has decreased for all samples. In the case of Kurunegala (ΔE=29.50) and Kandy (ΔE=29.37) flour are shown least colour deviation than other three areas. However time could be directly influence on reduction of colour difference (ΔE) of flour although it was stored in refrigerated and air–tightened condition. However this can be a focal point for food applications in future to choose better storage condition to keep original colour of the flour.

Keywords: Kithul flour, Refrigerated condition ,Colour variation, storage condition, shelf life, L* a* b* values

1. Introduction

Palms are aconstructive source of food products and medicine [1], and starch is a major renewable resource beside cellulose which forms the chief source of carbohydrate in the human diet [2]. Kithul (*Caryota urens*) palm ,which is indigenous to India, Malaysia, Myanmar, Nepal, and Sri Lanka[3],is identified as a multipurpose tree.It provides both edible and non-edible products. Edible products from Kithul tree include sweet toddy, Kithul treacle, Kithul toddy and Kithul jaggery as well as Kithul flour [1] which still remains as an unexploited resource in food industry.This flour which is equal in quality to industrial sago obtained from *Metroxylan Sagu Rottb*, plays a very important role as a food source [2].

For the industrial applications quality attributes are very critical, especially when Kithul flour is used to replace existing ingredients.Colour is a cause of perception and depends on interpretation as well as background differences (contrast effect), directional differences or observer differences or Size differences (area effect).To eliminate these errors ,and create a universal language for colour reading ,numerical system is the best method. By creating scales for hue, lightness, and saturation, colour could be transferred to a numerical value.

[4]. Colour is one of the most influential characteristics of a final food, especially in the case of flour as raw material,modern consumer mainly considers the overall appearance of the flour including the colour [4]. Colour of flour is a noiselesspointer for its novelty while it affects the overall point of view on food from both a tasteful and safety point of view [5]. In this way colour determination is one of the beneficialpoints which could be used for the improvement of flour quality.

The International Commission on Illumination (CIE) serves to define the location of any colour in uniform space by correlating the colour attributes of L*,a* and b* (1976) [6] which can be measured using a Chroma meter. This instrument enables users to directly determine the colour on the flour [7] by generating L*, a* and b* values. This readings subjective for the sensorial are brightness, lightness, hue, saturation, Chroma and colourfulness [8] . *L** is a function of measure of

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the brightness from black (0) to white (100) while *a** presents a function of the red-green difference. It varies between -60 to +60 while -a* goes from green and +a* goes towards red. b* is functioning for the green-blue difference. Positive *b** indicates yellowness and varies from -60 to +60, with -b* and +b* go towards blue and yellow, respectively[9]. This measurements of the *L*,a*,b** system presents the same perception of colour difference [10] by excluding human errors.

2. Materials And Method

2.1 Sample Collection: Five districts, namely Kurunegala (North-western province), Matale and Kandy (Central province), and Kegalle and Rathnapura (Sabaragamuwa province), were selected for the study as the five main growing areas in Sri Lanka. Six Kithul flour samples were collected from each district from both household and commercial markets.

2.2 Sample preparation and Storage: Samples were sifted through a 355µm sieve, packed in air-tight containers, and then stored in refrigerator (4 ºC) until further analysis.

2.3 Chroma meter Minolta (CR 400) colourimeter: The instrumental measurement of Kithul flour colour was carried out with a Chroma meter Minolta CR-400 (Konica Minolta colourimeter, sensing, Japan) and the results were expressed in accordance with the CIELAB system. The meter was calibrated with a white tile (L* = 93.30, a* = 0.32 and b* 0.33). The samples were poured into glass dishes(6.4 mm diameter diaphragm with an optical glass), and the surface of each sample was manually made flat. The measuring head of the meter was carefully placed on three different locations on the petri dish. The measurements were taken in triplicates and mean and standard deviation values were determined. The colour attributes were determined by colour coordinates of *L** (*L** = 0 [black] and *L** = 100 [white]), *a** (−*a** = greenness and +*a** = redness), and *b** (−*b** = blueness and +*b** = yellowness).

2.4 Shelf life studies: Keep the samples in air-tight containers, at 5 ºC in refrigerator for one year. Then readings were taken as per the section 2.3.

2.5 Statistical Analysis: Results were analyzed using one-way analysis of variance (ANOVA) and paired T-test at 0.05 probability level with MINITAB software package (version 17 for Windows).

3. Results and Discussion

The colour attributes of the Kithul flour treatments from five different growing areas in Sri Lanka is shown in Table 1. According to the results, there were significant differences among flour samples from five different growing areas for both L*(lightness) in initial and after one year values.But these two readings follows same pattern according to the superscripts except for samples from Kegalle area. Kandy (71.56) and Kurunegala (70.18) flours presented higher L* values than other flour treatments. Kithul flour samples from Matale (65.58) district has the lowest L* value at the initial stage. After one year, the lightness (L*) of all Kithul flour samples were increased and this could be attributed relationship of colour of flour vs the time of storage. Both stages (Initial flour samples and after one year flour samples) represent the mostly same significant difference pattern among areas .

The lowest a* value (4.54) was observed in Kandy flour samples while the highest values were reported from Kegalle (5.34) at the initial stage .But after one year redness has developed more in Ratnapura samples (6.02) while other samples (Matale,Kandy and Kegalle) also showed considerable redness .But in the case of Kithul flour samples from Kurunegala area showed reduction of redness when compare with the initial a* value.At the initial stage redness (a*) of Kithul flour presented significant differences as three groups based on superscripts as, Kurunegala, Matale in one group, while Kegalle and Ratnapura in another group and Kandy as third group.However at the final stage this pattern has changed in to four significantly different groups.

Table 1: Variations in Colour properties(L* ,a*,b*) of Kithul flour collected from five districts in Sri Lanka vs Shelf life

Sample	L*(Initial)	L*(after1 year)	a*(Initial)	a*(after1 year)	b*(Initial)	b*(after 1 year)
Kurunegala	70.18 ± 5.36^{ab}	71.66 ± 5.47^{ab}	4.71 ± 1.17^{ab}	4.51 ± 1.07^{c}	14.66 ± 1.58^{cd}	14.94 ± 1.50^{bc}
Matale	65.58 ± 3.95^{c}	66.10 ± 4.87^{c}	5.16 ± 0.89^{ab}	5.66 ± 0.70^{ab}	14.29 ± 1.04^{d}	14.19 ± 0.78^{c}
Kandy	71.56 ± 3.07^{a}	72.44 ± 2.72^{a}	4.54 ± 0.64^{b}	5.13 ± 0.77^{bc}	16.5 ± 0.82^{ab}	16.12 ± 0.66^{ab}
Kegalle	67.40 ± 1.28^{bc}	69.17 ± 0.5^{abc}	5.34 ± 0.40^{a}	5.63 ± 0.66^{ab}	17.90 ± 2.01^{a}	17.28 ± 1.92^{a}
Rathnapura	67.41 ± 2.78^{bc}	68.23 ± 2.9^{bc}	5.29 ± 0.54^{a}	6.02 ± 0.67^{a}	15.93 ± 1.97^{bc}	15.43 ± 2.71^{bc}

a,b,c Dissimilar letters indicate differences in treatment means within the same column ($p < 0.05$)

At the initial and final stage yellowness (b*) has presented significant difference among all areas (Table 01).The Kithul flour samples from Kegalle area recorded higher b* value (deeper yellow) of +17.90 and +14.29 was recorded by Matale area as lower b* value at the initial stage. However after one year yellowness has decrease from deeper to lighter in Kegalle as +17.28 and Matale as +14.19 .These could be attributed to the age of the Kithul flour (24 months) which made it very fibrous and resulted in the conversion of starch granules to sugars [11].

Table 2: Variations in Colour difference(ΔE) of Kithul flour collected from five districts in Sri Lanka vs Shelf life

Sample	ΔE(Initial)	ΔE(after 1 year)
Kurunegala	30.72±5.13[bc]	29.50±5.13[b]
Matale	34.77±3.90[a]	34.35±4.69[a]
Kandy	30.24±2.71[c]	29.37±2.73[b]
Kegalle	34.65±1.34[a]	32.87±0.82[a]
Rathnapura	33.81±2.33[ab]	33.08±2.21[a]

[a,b,c]Dissimilar letters indicate differences in treatment means within the same column ($p < 0.05$)

The differences in colour could be attributed to the variety, age and also different processing procedures for flour.The larger the ΔE value represents, the larger the colour difference [12].The estimation of ΔE, indicate the extent of deviation of colour of samples from the standard tile colour used (L*=97.63, a*=- 0.48, and b*=+2.12). From the results the flour samples from Matale (ΔE=34.77) and Kegalle (ΔE=34.65) had a greater deviation from the standard colour value than the other samples (Table 2). Kandy area presented the lowest deviation from standard as ΔE=30.24 at the initial stage. With time colour difference has decreased for all samples. Floor samples from Kurunegala (ΔE=29.50) and Kandy (ΔE=29.37) has shown the least colour deviation compared to flours from other three areas.

Above area wise comparison which has analyzed by ANOVA one–way variance showed differences from results which were test. L* value has significantly changed (P<0.05) after a one year storage period according to the results of paired T-test. Lightness (L*) has improved. It can clearly identify by Figure 01,which is graphed with mean L* value of Kithul flour from different areas.

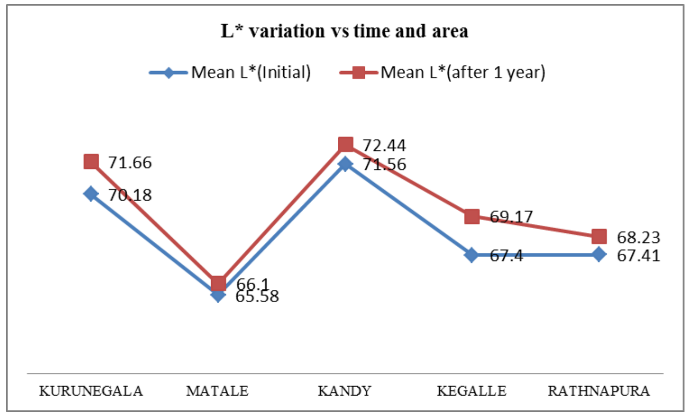

Figure 1: Figure 1. L* variations of Five districs Kithul Flour samples vs Time

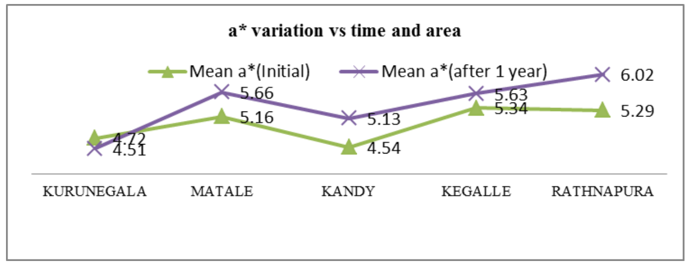

Figure 2: Figure 2. a* variations of Five districs Kithul Flour samples vs Time

Although based on paired T-test a* value (P>0.05) and b* value (P>0.05) has not significantly changed after one year time period, while graphs of mean value of redness (a*) and yellowness (b*) in area wise comparison shows more reddish (Fig.02) and low yellowness(Fig.03) tones (higher a* and lower b* values) as compared to initial stage of Kithul flour.

Variations in ΔE of mean values among different growing areas behave as per the Figure 4. ΔE value has decreased after one year time period in all Kithul flour samples from five different growing areas. Again it was proved by paired T-test. ΔE value has significantly changed (P<0.05) after a one year storage period .It showed clear cut observation as time could directly affect colour differences of flour although refrigerated in air – tighten conditions.

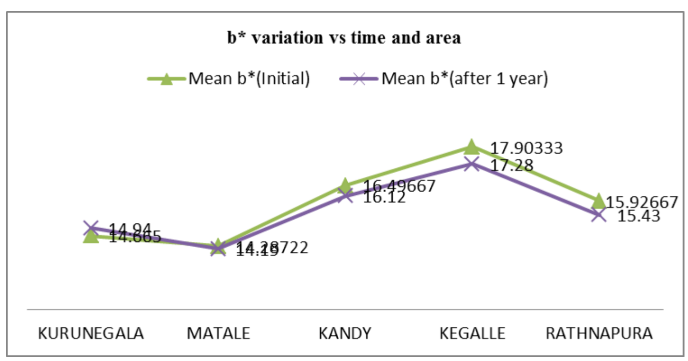

Figure 3: Figure 3. b* variations of Five districs Kithul Flour samples vs Time

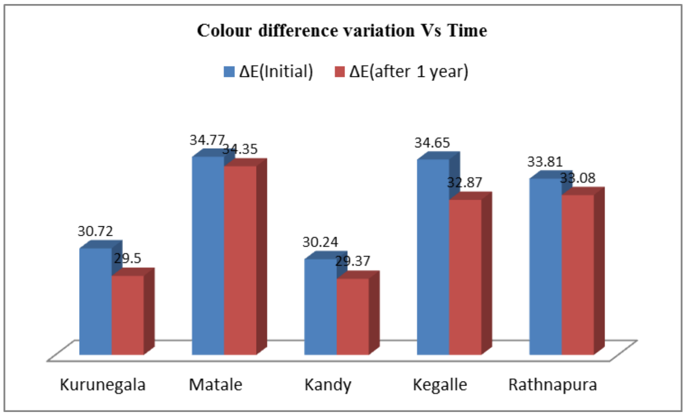

Figure 4: Figure 4. Variation of Colour difference vs Time

4. Conclusion and Further Work

Kithul flour samples collected from five main growing areas presented significant differences($p< 0.05$) with respect to colour attributes such as L* (lightness) value, a* (redness) value, and b* (yellowness) values. Further colour attributes of flour sample significantly changed during shelf life. According to the instrumental measurements, L* value has significantly changed ($P<0.05$) after one year time period. Lightness has improved. Nevertheless a*and b* value has not significantly changed after one year time period. However +a* (redness) has improved while +b* (yellowness) has decreased with the time.According to the colour attributes of flour samples Matale (ΔE=34.77) and Kegalle (ΔE=34.65) had a greater deviation from the standard colour value than the other samples. Kandy area presented the least deviation from standard as ΔE=30.24 at the initial stage. With time colour difference (ΔE) has decreased significantly ($P<0.05$). Kurunegala (ΔE=29.50) and Kandy (ΔE=29.37) flour have shown least colour deviation than other three areas.

This study reveals that the colour attributes of Kithul flour can be influenced by the growing area as well as time of storage. This can be a focal point for food applications in future as composite flours with similar colours can be produced using Kithul flour obtained from different growing areas as well as different storing condition in different shelf lives. Flour colour often affects the colour of the finished product and therefore it will be one of key flour specifications which require keen attention of food technologists to empower the Kithul flour industry.

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