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CHEMICAL COMPOSITION AND POTENTIAL ADULTERANTS IN COCONUT MILK SOLD IN KUALA LUMPUR

SHAFRINA AZLIN-HASIM, QUEE LEE SIANG, FADLINA YUSOF, MOHAMAD KHAIRI ZAINOL and HAYATI MOHD YUSOF*

School of Food Science and Technology, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia
**E-mail: hayatimy@umt.edu.my*

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ABSTRACT

The purpose of this study was to determine the chemical composition of six fresh coconut milk samples sold in Kuala Lumpur and to compare the results of chemical composition with pure coconut milk as reference using Malaysia Food Composition, USDA Fresh Coconut Milk Composition and USDA Canned Coconut Milk Composition. The possible source of adulterants that might present in coconut milk was also studied. Two fresh coconut milk samples from Pasar Imbi and Giant Cheras was anticipated to be adulterated with water and a source of carbohydrate in order to thicken the coconut milk. The protein content of fresh coconut milk sample from Pasar Imbi and Giant Cheras was 79.05% and 80.95%, respectively, lower compared to the reference, while the fat content was 53.38% and 60.96% lower compared to the value of the reference. However, the carbohydrate was 16.37% and 5.75%, while the moisture content was 12.84% and 25.77% higher compared to the value of the reference. From these two potentially adulterated coconut milk samples, only coconut milk from Pasar Imbi shown carbohydrate (corn flour) and water peaks of Fourier transform infrared (FTIR) spectra. The spectra of fresh coconut milk adulterated with different concentration of corn flour were scanned and interpreted. Partial Least Square (PLS) regression was used to quantitatively determine the concentration of corn flour in the coconut milk. The linear equation of the validation obtained was $y = 0.9161x + 0.3334$ with $R^2 = 0.9982$ and RMSEC= 0.688. This can be suggested that FTIR could be a potential tool in determining the coconut milk adulteration with corn flour for future study.

Key words: Chemical composition, coconut milk, adulteration, corn flour

INTRODUCTION

Nowadays, food adulteration is an emergent menace in which unscrupulous food merchants and producers around the world indulge in for the purpose of obtaining an economic advantage by exploiting the gullible consumer (Dasaraju *et al.,* 2012). Adulteration of food is defined as an intentional addition or replacement of food ingredients with cheaper alternatives for sale or removal of certain valuable ingredient result in debasing the food quality (Balani, 2013). Furthermore, preparation of foods using artificial ingredients and label them as natural products could also be considered as food adulteration. However, substitution is the main category, as reported by Moore *et al*. (2012) that 95% of record from academic journal involved either partial or complete replacement of an authentic substance with the less valuable substitute. Therefore, detection of food adulteration is important and necessary in term of monitoring the food quality as food adulteration is rampant throughout the world.

Coconut milk is one of the most vulnerable food which can be adulterated very easily. Coconut milk is a milky oil-in-water emulsion obtained from aqueous extract of coconut flesh (Chiewchan *et al.,* 2006). In Malay word, coconut milk is known as "santan". Several researchers state that coconut milk is much healthier than other saturated fat products as it is high in saturated fat that is mostly in the form of medium-chain fatty acids (MCFA) which is easily metabolized by the body (Zhu *et al.,* 2014). The MCFA, mostly lauric acid (C 12:0), representing 45–53% of total fatty acids (Raghavendra & Raghavarao, 2010). The MCFA had a high anti-microbial potential against bacteria, fungi, viruses and protozoa (Parfene *et al.,* 2013). The lauric acid

* To whom correspondence should be addressed.

will be converted in the body to monolaurin which is a compound also found in breast milk that strengthens immunity (Mercola, 2012). Besides, MCFA has tremendous healing power and enhancing nutrient absorption but when coconut milk is adulterated, the beneficial effects will be lost and may lead to health problems that can further increase risk of mortality and high morbidity. Hence, it is necessary to analyse the food composition of coconut milk in order to detect any adulterants which are harmful for consumption.

In Malaysia, coconut milk plays an important role in the socio-economic position of the Malaysian population. According to Sivapragasam (2008), about 63% of coconut production is for domestic consumption and 37% is for export and industrial processing. It is due to the high demand from Malaysian population from day to day especially Malay as coconut milk is widely used as an important ingredient in many traditional foods especially in curries, nasi lemak and desserts. In addition, the increase in demand also can be attributed not only to its various function but also to its potential health benefits. However, severe competition with oil palm for land has resulted in a decline of the total area under coconut cultivation in Malaysia during the period 1990-2010 (Mahindru, 2009). Therefore, the current situation of high coconut milk demand but low supply existed. So, food producers prone to adulterate coconut milk which lead to lower quality of coconut milk and increase the food hazard.

From the previous research, coconut milk adulteration has been detected by moisture analysis and Fourier Transform Infrared (FTIR) spectra analysis (Voon, 2015). Interestingly, among the samples tested, fresh coconut milk sample purchased from a hypermarket in Terengganu might be adulterated with corn flour and water. To the best of our knowledge, only one study has been conducted in Terengganu, Malaysia regarding the detection of coconut milk adulteration. Therefore, we would like to extend a similar study to Kuala Lumpur, Malaysia which study on the detection of adulteration of coconut milk, which were corn flour and water.

MATERIALS AND METHODS

Materials

Seven samples of liquid coconut milk were used in this study, including one control sample and six samples of fresh coconut milk were purchased from different local markets in Kuala Lumpur as follow:

C1 – Fresh coconut milk purchased from Giant Cheras.
C2 – Fresh coconut milk purchased from Aeon Big.
C3 – Fresh coconut milk purchased from Topzeller Wangsa Maju.
C4 – Fresh coconut milk purchased from Pasar Besar Selayang.
C5 – Fresh coconut milk purchased from Pudu Wet market.
C6 – Fresh coconut milk purchased from Pasar Imbi.
C7 – Homemade pure coconut milk (control).

Sample preparation of fresh coconut milk

The fresh desiccated coconut was pressed using the hydraulic press machine to obtain the fresh coconut milk without the addition of water.

Chemical analysis

The chemical analysis of carbohydrate, protein, total fats and moisture content of all pure coconut milk samples were carried out in duplicate. Besides, Nestle Full Cream Milk, Ensure Infant Formula and Jacob Weetameal Crackers were used as standard reference materials. Standard reference materials are aimed to improve analytical methods performances and enhances quality assurance of analytical results for chemical compositions. The analysis was carried out with ten replications in separate days.

Carbohydrates analysis

Carbohydrate content was determined using the UV-Vis Absorption Spectrophotometer (Albalasmeh *et al*., 2013). The samples were prepared by added 3 grams of coconut with 50 mL of water and placed into the conical flask. The mixture was heated at 60°C and stirred for 10 minutes. Then, the mixture was filtered into a 100 mL volumetric flask. Any residues left were rinsed with a little distilled water and was diluted into 100 mL of solution. Then the calibration curve was prepared by making glucose solutions with the concentration of 0.25, 0.5, 1.0, 1.25, 1.5, 2.0 and 2.5 mg/mL by diluting the stock glucose solution using a 100 mL volumetric flask and distilled water.

A volume of 1 mL of each standard glucose solution and the sample was pipetted into a labelled test tube respectively, and 1 mL of distilled water was pipetted into a test tube as blank for Colorimetric Method. Then, 1 mL of Dinitrosalicylic Acid (DNS) reagent and 2.0 mL of distilled water was added into the test tubes. All the test tubes were heated in a boiling water bath for 5 minutes. The solution was then diluted with 20 mL of distilled water after cooled.

The absorbance spectrum in the visible light range (350–800 nm) for three standard solutions of 0.25, 1.0 and 1.5 mg/mL glucose was determined and the maximum wavelength was selected to study the maximum absorbance as a function of concentration. The standard solution and concentration of the sample were determined by the maximum wavelength that had been chosen (Albalasmeh *et al*., 2013). The graph of absorbance against concentration for standard solution and samples was plotted. The straight line is drawn using the linear regression and the concentration of reducing sugar in the sample was determined from the Beer Law right curve (Albalasmeh *et al*., 2013).

Protein analysis

Kjeldahl method was used to determine the protein concentration of coconut milk according to AOAC Procedures (1999) (method 981.10) (AOAC, 2000).

Total fat analysis (dry matter basis)

Soxhlet Extraction with the model Labtec ST310 was used to determine the fat content of coconut milk (AOAC, 2000). The sample was freeze-dried and then dried in an oven for 2 hours before carrying out the analysis. One gram of the sample was weighted in filter paper and placed in the thimbles. A volume of 40 mL of petroleum ether was filled in the aluminium cup (previously dried in an oven for 2 hours, cooled and weighted). The thimbles were attached to the adapters and aluminium cup was clamped into the condensers. The program was started by pressing the starter key. A boiling process started when the set temperature (115°C) reached. After 30 minutes, rinsing process started by moving the extraction mode knobs to rise position and the recovery process started by closing the condenser valves after 15 minutes of rinsing. Then, the pre-frying process started after the recovery process. The aluminium cup was dried in an oven at the temperature of 105°C for 1 hour, cooled and weighted after the pre-drying process completed.

Moisture analysis

The crucible with the lid was dried in the oven at the temperature of 100°C for 30 minutes and cooled in a desiccator. After cooled, the crucible was weighted without the lid. Two grams of the sample was weighted in the crucible. The crucible was dried in an oven (100°C) overnight (the crucible was semi-closed with the lid). After 24 hours, the crucible was cooled in a desiccator with the lid closing. The weight of the crucible was weighted without the lid after cooled.

Detection of adulteration in coconut milk

The spectra of coconut milk samples and pure coconut milk adulterated with corn flour were determined using the FTIR (Nicolet, Thermo Electron) by Deuterated Triglycine sulphate (DTGS) detector in the range of 4000 to 650 cm^{-1} at 4 cm^{-1} resolution with 32 number of scans (Quinones-Islas *et al*., 2013).

Different calibration set was prepared by spiking the corn flour into the pure coconut milk with the concentration of 0%, 0.2%, 0.5%, 1.0%, 1.5% and 2.0%. Other sets of sample containing 0.8%, 1.2%, 1.8% and 100% corn flour were prepared for validation. The variations in the spectral region that was observed were chosen for developing the partial least squares (PLS) model (Quinones-Islas *et al*., 2013).

Statistical analysis and validation

The relationship between the actual concentration of corn flour and the predicted value by FTIR was determined using the software TQ analysis. A PLS approach was chosen to develop the calibration model and it was validated by the validation process. Microsoft Excel 2013 spreadsheet was used to correlate the relationship between the actual value and FTIR predicted value (Syahariza *et al*., 2005).

Data are presented as mean (SD) of duplicate measurements from two independent experiments. One-way ANOVA was used to determine the differences of carbohydrates, protein, total fats and moisture content among the samples, USDA references and Nutrient Composition of Malaysian Foods. Tukey's multiple comparison post-hoc test was used to conduct a whole set of comparison by comparing the differences between each group. In all analysis, the level of significance was set $p < 0.05$ indicates a difference between the mean score on the dependent variable for the groups.

RESULTS AND DISCUSSION

Chemical analysis of fresh coconut milk

Six samples C1 until C6 were fresh coconut milk purchased from different places of the market in Kuala Lumpur and sample C7 as a reference which was prepared in the laboratory without any addition of water and additives. The results of chemical analysis of coconut milk purchased from different places are presented in Table 1.

Table 1. Results of chemical analysis purchased in different places*

Sample	Carbohydrates (g/100 g)	Protein (g/100 g)	Fat (g/100 g)	Moisture (g/100 g)
C1	2.39 ± 0.10^{a}	0.80 ± 0.01^{b}	7.11 ± 0.84^{a}	89.35 ± 0.61^{a}
C2	2.13 ± 0.04^{b}	2.31 ± 0.04^{ab}	9.41 ± 1.35^{ab}	86.37 ± 0.07^{a}
C3	1.19 ± 0.08^{c}	1.39 ± 0.14^{b}	12.37 ± 0.71^{ab}	79.82 ± 0.42^{b}
C4	1.83 ± 0.13^{bc}	1.86 ± 0.04^{b}	13.24 ± 1.80^{ab}	78.76 ± 0.24^{b}
C5	2.17 ± 0.11^{b}	1.29 ± 0.16^{b}	15.48 ± 0.16^{bc}	79.37 ± 1.44^{b}
C6	2.63 ± 0.18^{a}	0.88 ± 0.08^{b}	8.49 ± 0.85^{a}	80.16 ± 1.17^{b}
C7	2.26 ± 0.06^{b}	4.20 ± 0.20^{a}	18.21 ± 1.25^{bc}	71.04 ± 0.65^{c}

*Data are mean ± SD per 100 g from the chemical analysis in two replications.

Table 2. Carbohydrate, Protein and Fat Content of Coconut Milk and the 5%Trimmed Mean

	Mean (g/100 g)			5 % Trimmed Mean (g/100 g)		
	Carbohydrate	Protein	Fat	Carbohydrate	Protein	Fat
Fresh Coconut Milk	2.06	1.42	11.02	2.15	1.34	10.89

From the table, it is shown that fresh coconut milk purchased from Pasar Imbi and Giant Cheras (C6 and C1) had many variations in the carbohydrate, protein and fat content as compared to the reference (C7). Fresh coconut milk from Pasar Imbi (C6) shown a lower concentration of protein and fat content as compared to the reference (C7). The protein showed a variation of 79.05% lower, while the fat content showed a variation of 53.38% lower than reference, C7. It is well known a close relationship between the content of carbohydrate, protein and fat of fresh coconut milk. This is because when the protein and fat content of sample C6 are lower than the reference (C7), the carbohydrate content should also be lower as compared to the other samples. However, the carbohydrate and moisture content of sample C1 and C6 were significantly ($p<0.05$) higher compared to the reference (C7). These samples (C1 and C6) also showed to have significantly ($p<0.05$) lower protein and fat content compared to the reference (C7). Therefore, it was anticipated that fresh coconut milk samples from Giant Cheras (C1) and Pasar Imbi (C6) might be adulterated with a source of carbohydrates.

Corn flour is popular and has the greatest potential to be the source of emulsifier that contributes to the high carbohydrate content of the fresh coconut milk sample; C1 and C6. Starch from corn flour is the main storage carbohydrate in plants. It can be widely applied in various branches of the food industry based on the adhesive and thickening properties, the ability to form films and gels, as well as its low cost and quality control (Soto *et al.*, 2014). Therefore, many food manufacturers like to use corn flour in order to make liquid consistency of coconut milk looks similar to pure coconut milk. This can be achieved as the corn starch swell (Cichero, 2013).

Comparison of fresh coconut milk samples with standard references

The samples which are the six fresh coconut milk purchased from the market in Kuala Lumpur were tested. The 5% trimmed value was determined using SPSS software to assess whether there is a sample that leads to high variation in the mean of carbohydrate, protein and fat content of coconut milk. Results in Table 2 shown the 5% trimmed mean is the mean value that will be obtained if the upper and lower 5% of the value of the variation was deleted.

From the table, it shown the mean value of protein content of fresh coconut milk was 1.42 g/100 g while the 5% trimmed mean was 1.34 g/100 g. For fat, the mean value was 11.02 g/100 g while the 5% trimmed mean was 10.89 g/100 g. Two of the fresh coconut milk sample, C1 and C6 had a lower mean value of protein (5.63%) and fat content (1.18%). Therefore, in one-way ANOVA analysis, sample C1 and C6 were eliminated from the other coconut milk and placed at the category of potentially adulterated coconut milk samples.

For the objective to determine whether there was any significant difference of the carbohydrate, protein and fat content among the fresh coconut milk, reference (C7), potentially adulterated coconut milk samples, Malaysia Food Composition, USDA fresh coconut milk composition and USDA canned coconut milk composition, one-way ANOVA were

Table 3. Carbohydrate, protein, fat and moisture content of coconut milk samples

Groups/ Mean (g/100 g)	Carbohydrate	Protein	Fat	Moisture
Fresh Coconut Milk from Local Market(C2, C3, C4, C5)	1.83^{b}	1.71^{b}	12.63^{bc}	81.08^{a}
Reference (C7)	2.26^{b}	4.20^{a}	18.21^{abc}	71.04^{b}
Potentially Adulterated Coconut Milk(C1 and C6)	2.51^{b}	0.84^{b}	7.8^{c}	84.76^{a}
Malaysia Food Composition	2.8^{b}	2.6^{ab}	26.9^{a}	64.9^{c}
USDA Fresh Coconut Milk Composition	5.5^{a}	2.3^{ab}	23.8^{ab}	67.6^{c}
USDA Canned Coconut Milk Composition	2.8^{b}	2.0^{ab}	21.3^{ab}	72.9^{b}

*Means showing the same superscript letter in the same column are not significantly different ($p>0.05$).

carried out. Post-hoc Tukey test is then performed to determine the differences between groups. The results are shown in Table 3.

From Table 3, it can be seen that there is no significant difference ($p>0.05$) between the carbohydrate content of potentially adulterated coconut milk (C1 and C6) with reference sample (C7) and Malaysian Food Composition. This might because the coconut milk has been adulterated with a source of carbohydrates to mimic the pure coconut milk in term of their consistency and carbohydrate content. Therefore, it is still anticipated that coconut milk, C1 and C6 might be adulterated with a source of carbohydrates based on their low protein and fat content as compared to the reference (C7).

Furthermore, the results show that all samples tested are significantly different ($p<0.05$) in the mean of carbohydrate content compared to the USDA fresh coconut milk composition. In addition, the carbohydrate content of the reference published by USDA (5.5 g/100 g) was 96% higher compared to the Malaysian Food Composition (2.8 g/100 g). The variation in the carbohydrate content may due to the difference in the maturation of nuts which lead to various carbohydrate content. For instance, with the increasing maturity, the concentration of total sugars decreases (Siddiq, 2012). Besides, the differences in species of the coconut also will contribute to different carbohydrate content in coconut milk. For example, "Makapuno" which is a specialty coconut lacks α-galactosidase activity which causes the accumulation of high levels of water-soluble galactomannan (major carbohydrate reserves in seed endosperm) rather than water-insoluble mannan that found in normal coconut milk (Luengwilai *et al.*, 2014). This contributes to high carbohydrate content in "Makapuno". In addition, "Kopyor" coconut which is a matured coconut with broken meat particles in the watery endosperm due to abnormal formation of the kernel during the development of the fruits also has this similar feature to "Makapuno" (Santoso *et al.*, 1995). Therefore, the difference in the maturity and species of the coconut might be the reason of the difference in carbohydrate content of coconut milk in the data published by USDA with Malaysia Food Composition and other fresh coconut milk samples.

The significant different ($p<0.05$) between the protein content of potentially adulterated coconut milk purchased from the local market as compared to the reference (C7-pure coconut milk) (Table 3). However, the potentially adulterated coconut milk shown no significant different ($p>0.05$) in protein content as compared to the Malaysian Food Composition, USDA Fresh Coconut Milk Composition and USDA Canned Coconut Milk Composition. It was found that the protein content of potentially adulterated coconut milk was 67.69%, 63.48% and 58% lower than Malaysia Food Composition, USDA Fresh Coconut Milk Composition, and USDA Canned Coconut Milk Composition. The decreasing of protein content in coconut milk is probably caused by the increasing of other nutrients like carbohydrates and water which increase more rapidly than the proteins and higher compared to the reference (C7), thus, protein content in coconut milk water become lower (Sinaga *et al*., 2015).

For fat content, there is no significant different ($p>0.05$) between the fresh coconut milk (C2, C3, C4 and C5) and reference (C7-pure coconut milk) with the potentially adulterated coconut milk (Table 3). However, the fat content of the potentially adulterated coconut milk showed 38.24% and 57.71% lower than fresh coconut milk and reference (C7). In addition, the fat content of potentially adulterated coconut milk showed significant lower ($p<0.05$) by 71.00%, 67.23% and 63.38% than Malaysia Food Composition, USDA Fresh Coconut Milk Composition and USDA Canned Coconut Milk Composition, respectively. Lower fat content is probably due to the increase of carbohydrate and water content in potentially adulterated coconut milk (Santana *et al.*, 2011).

Fat content for fresh coconut milk (C2, C3, C4 and C5) shown 30.64% lower than the reference (C7), 53.05% lower than Malaysia Food Composition, 46.93% lower than USDA Fresh Coconut Milk Composition and 40.70% lower to USDA Canned Coconut Milk Composition. As these fresh coconut milk does not show increasing in

carbohydrate content, the lower in fat content might be due to other factors such as the coconut are immature or obtained from the dwarf coconut (Santana *et al.*, 2011).

Although there is no significant difference in the fat content of Malaysia Food Composition with USDA Fresh Coconut Milk Composition and USDA Canned Coconut Milk Composition, it still showed 13.02% higher than USDA Fresh Coconut Milk Composition and 26.29% higher than USDA Canned Coconut Milk Composition. This might due to data of Malaysian Food Composition is from local planted coconut which undergoes a longer period of dry weather that might accelerate the nut maturation. As a result, mature coconut contributes to higher fat content than the immature coconut (Tanqueco *et al.*, 2007).

The result of moisture analysis showed that fresh coconut milk has significantly ($p<0.05$) higher moisture content by compared to the reference, Malaysian Food Composition, USDA Fresh Coconut Milk Composition and USDA Canned Coconut Milk Composition. According to Chuntarat *et al.* (2015), the coconut kernel at different maturity stages have various moisture and total carbohydrate content. For example, the 6-months coconut kernel contained the highest moisture content (58.5%), and total carbohydrate (18.7%). Therefore, the difference in the maturity of coconut kernel might be the reason for higher moisture content in fresh coconut milk. In addition, the moisture content of potentially adulterated coconut milk has significant higher ($p>0.05$) moisture content than the reference (C7), Malaysian Food Composition, USDA Fresh Coconut Milk Composition and USDA Canned Coconut Milk Composition. Therefore, it can be anticipated that sample C1 and C6 might be adulterated with water due to high moisture content.

Detection of potential adulteration

FTIR with ATR technique was used to analyze all fresh coconut milk samples (C1–C7) in the mid-infrared region of 4000 cm^{-1} to 650 cm^{-1}. From Table 4, between the potentially adulterated coconut milk (C1 and C6), only sample C6 shown peak from carbohydrate. Besides that, FTIR spectra also showed peaks from water (1634 cm^{-1}, 2111 cm^{-1} and 3319 cm^{-1} for -OH stretch) and carbohydrate, at frequency 997cm^{-1} which represent the presence of corn flour (source of carbohydrate), while the peaks from protein and fat are absent. Therefore, it can be concluded that fresh coconut milk, C6 which was purchased from Pasar Imbi was suggested to be adulterated with a source of carbohydrate (corn flour) and water.

Calibration and validation model for detection of corn flour

The frequency range 985 cm^{-1} to 1005 cm^{-1} was selected to determine the amount of corn flour present in the coconut milk quantitatively. Calibration model was calibrated with pure coconut milk, coconut milk adulterated with 0%, 0.2%, 0.5%, 1.0%, 1.5% and 2.0% corn flour. The relationship between the actual value of the sample and the FTIR calculated value is shown in Figure 1 (a). A good linear equation $y = 0.8692x + 0.16$ was obtained with $R^2 = 0.9703$ and RMSEC = 0.184.

A validation model for corn flour was developed after calibration. This validation model was developed by using pure coconut milk, corn flour, coconut milk adulterated with 0.8%, 1.2% and 1.8% corn flour. The relationship between the actual value of the sample and FTIR calculated value of validation model is shown in Figure 1 (b). The linear equation obtained was $y= 0.9161x + 0.3334$ with $R^2 = 0.9982$ and RMSEC = 0.688.

CONCLUSION

From the potentially adulterated coconut milk (C1 and C6), only the spectra of coconut milk, C6 shown peak from carbohydrate. Besides, its FTIR spectra also showed peaks from water and carbohydrate, at frequency 997 cm^{-1} which might represent the presence of corn flour (source of carbohydrate), while the peaks from protein and fat are absent.

Table 4. FTIR peaks that present in the coconut milk sample

Sample/cm^{-1}	1500–900	1634	2111	1701–1507	1742	2852 & 2921	2956	3319
C1		√	√					√
C2	√	√	√	√	√		√	√
C3	√	√	√		√			√
C4		√	√		√			√
C5		√	√					√
C6	√	√	√					√
C7 (reference)	√	√	√	√	√	√	√	√

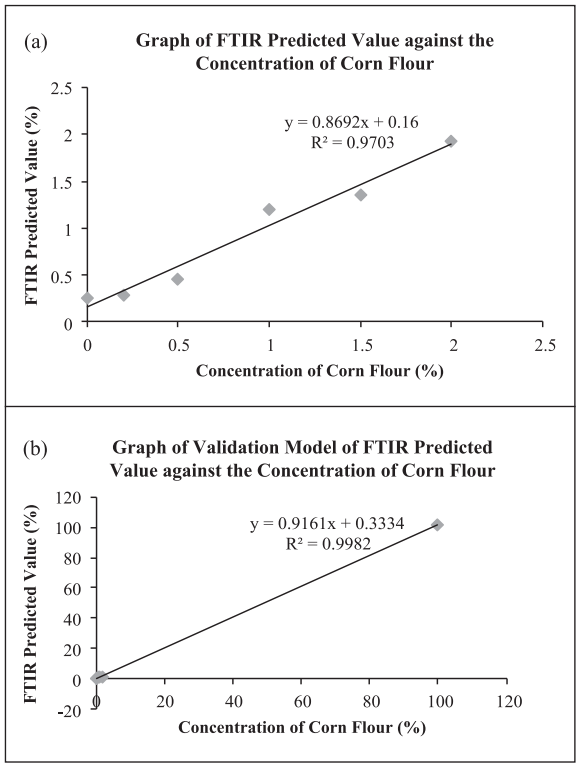

Fig. 1. (a) Graph of calibration model of FTIR predicted value (%) against the concentration of corn flour, and (b) Graph of validation model of FTIR predicted value (%) against the concentration of corn flour.

Therefore, it can be concluded that fresh coconut milk, from Pasar Imbi (C6), may be adulterated with a source of carbohydrate (corn flour) and water.

The present study document the current coconut milk composition as compared to the Malaysia Food Composition Database. Furthermore, it also documents that USDA reference for coconut milk is not appropriate for use due to the 96% variation of its carbohydrate content compared to Malaysia Food Composition. This is due to the difference in the maturity and species of coconut used to obtain coconut milk.

All the fresh coconut milk tested including the reference, sample C7 does not comply with the requirement of Malaysia Food Regulation 1985 which stated that coconut milk shall contain not less than 3% of protein and not more than 55% of water. This result showed that regulation in protein and water content are not reliable to use.

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