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Nutrient Compositions and Total Polyphenol Contents of Selected Dried Fruits Available in Selangor, Malaysia

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Abstract

Dried fruits contained higher amount of energy and nutrient density compared to the fresh ones. This study was conducted to determine and compare the content of nutrients and polyphenols in dried dates, raisin, apricot and fig. Dried fruit samples were bought from three different stores in Selangor and analyzed in triplicates. AOAC (1997) standard methods were used for proximate analyses. The total sugar and polyphenol contents were determined using Dubois and Folin-Ciocalteu methods, respectively. Highest moisture content was found in dried apricots (35.26%) while the lowest one was in Mariami dates (21.68%). Dried apricots also contained highest total ash content (4.54%) while Safawi dates have the lowest one (2.45%). Dried figs contained the highest crude protein (3.93%) and fat contents (4.02%) while Safawi dates have lowest protein (2.57%) and fat (0.09%) contents. Total carbohydrates were highest in Safawi dates (72.81%) and lowest in dried apricots (56.09%). Highest total sugar content found in Mariami dates (48.61%) and lowest in dried apricots (10.35%). Total phenolic content in golden raisin contained significantly ($p < 0.001$) highest polyphenol content (562.15 mg GAE/100 g) than others while dried figs have the lowest one (151.04 mg GAE/100 g). Dried fruits analyzed in this study contained high nutrients and polyphenol contents which are suitable to be consumed as an alternative for snack, with a caution on the portion size due to the high sugar content.

Keywords: dried fruits, nutrient, polyphenol, sugar

1. Introduction

Dried fruits have been consumed regularly by people in various countries with raisins as the most preferred dried fruits by people in the Mediterranean countries (Camiri & Dougherty, 2003). The process of removing moisture during production of dried fruits has increased its shelf life (Serio et al., 2014). The total energy density, nutrient contents, dietary fiber and antioxidant activity in dried fruit are higher compared to fresh fruit which depends on the concentration of the existing compounds (Caglarirmak, 2006). Moreover, the high total sugar concentration and appropriate temperature during drying process can also enhance the antioxidant activities of the dried fruits (Moreno et al., 2007). However, drying process can contribute to the reduction of polyphenol content and changes in the total polyphenol ratio in dried fruits (Vinson, 2005). There are several types of polyphenols present in fresh fruits that can be destroyed or converted to non-antioxidant form during the drying process (Ferreira et al., 2000).

Polyphenols are plants' secondary metabolites and can act as antioxidant that present abundantly in the human diet (Butterfield et al., 2002). Polyphenols possessed several beneficial characteristics such as antioxidant, anti-aging, anti-carcinogenic, anti-inflammatory and help in the improvement of endothelial function (Han et al., 2007). Polyphenols has gained much attention by food scientists, nutritionists, agricultural and food industries and consumers due to the association between the consumption of a diet rich in plant sources with disease risk reduction such as cancer and cardiovascular disease as well as type 2 diabetes (Scalbert et al., 2005; Arts & Hollman, 2005).

Dates (*Phoenix dactylifera*) are one of the oldest cultivated plants and widely available in Asia, Middle East and Africa. Dates was cultivated throughout the year in the countries with hot and dry climate with little rain and high soil salinity and alkaline content such as in Asia, Middle East and Africa (Chao & Krueger, 2007). The dates can be considered as an almost ideal food because of the nutrient contents and the beneficial effect to health (Al-Shahib & Marshall, 2003). There are thousands of date varieties that usually classified based on the texture of the dates from soft to dry (Arias-Jimenez, 2002). Ajwa dates are originated from Madinah (Saudi Arabia) which hold historical and religious importance and highly demanded since been consumed by Prophet Muhammad (peace be upon him) (Ragab et al., 2013). They are small in size, black in color with soft texture. Safawi dates also come from Saudi Arabia and the size forms are varieties depend on their grade. They have dark brown color with soft and chewy texture. While Mariami dates also known as Piarom dates are originated from Iran which look almost the same as Safawi dates but have semi-dried texture. Raisin (*Vitis vinifera* L.) originated from grapes that have been dried either from sunlight exposure, water-dipped or drying machine. Polyphenols that are present abundantly in raisins include quercetin, kaempferol, caftaric acid and coutaric acid with the golden raisin possessed the highest polyphenol content compared to other types of raisins (Williamson & Carughi, 2010). The loss of moisture content through the drying process has altered the nutrient composition in grapes and resulted in the increment of the total sugar concentration (Franco et al., 2004).

Apricot (*Prunus armeniaca* L.) has a unique taste, texture and color depending on the quality of the apricots produced (Erdogan-Orhan & Kartal, 2011, Solis-Solis et al., 2007). Apricots are rich in phenolic compounds such as catechin, epicatechin, p-coumaric acid, caffeic acid, ferulic acid and esters (Arts et al., 2000; Hodek et al., 2006). This fruit also have a good proportion of dietary fiber, sugar and mineral contents such as potassium, zinc, selenium, calcium, phosphorus, magnesium and iron. It is also rich in of vitamins A, C, niacin, thiamine, pantothenic acid and riboflavin (Durmaz et al., 2010). Figs (*Ficus carica* L.) was originated from the family of *Moraceae* are the most important food in the Mediterranean diet and was associated with longevity thus becoming of one of the healthiest foods of the association with longevity (Trichopoulou et al., 2006). Fig is an excellent source of phenolic compounds, higher than two other foods namely red wine and tea (Vallejo et al., 2012). Fiber, potassium, calcium and iron content in figs is much higher than commonly consumed fruits such as bananas, grapes, oranges, strawberries and apples (Michailides, 2003).

Previous local study had only analyzed the polyphenol content and antioxidant capacity of dates (Biglari et al., 2008). Moreover, studies on raisins, figs and apricots were conducted in India and the Middle East countries but rarely studied in this country. There is a limited data on nutrient content of the dried fruit in the Malaysian Food Composition Database (MyFCD) especially for raisins, figs and apricots. Nutrient content database for dates available in MyFCD, are only for dates in general, but not for the specific types of dates. Thus, this study aimed to provide additional information on food nutrient composition of dried fruits, especially for various type of dates, raisins, dried apricots and dried figs, thus to update the MyFCD. In addition, differences in the polyphenol and nutrient contents for all selected dried fruit were evaluated in this study.

2. Materials and Methods

2.1 Chemicals and Reagents

Gallic acid, Folin-Ciocalteu, sodium carbonate reagents were purchased from Sigma Aldrich, USA. Petroleum ether, boric acid with green bromocresol, sodium hydroxide, potassium sulphate and copper sulphate were purchased from Systerm ChemAR. Mineral stock solutions (Calcium (Ca), Ferum (Fe), Potassium (K), Magnesium (Mg), Zinc (Zn)), glucose, phenol, ethanol, methanol, sulphuric acid and hydrochloric acid were of analytical quality grade.

2.2 Dried Fruit Samples

A total of seven types of dried fruits were selected for this study (Figure 1), which included three types of dates, two types of raisins, dried apricot and dried fig. The samples were purchased from three different locations in Selangor, Malaysia namely Ampang, Shah Alam and Kajang. Samples were selected based on the market availability and its popularity among local people which were identified through market survey.

Figure 1. Selected dried fruits used in this study

2.3 Sample Preparation

Dried fruit samples purchased from three locations were cut into small pieces and divided into two portions. First sample portion was dried using drying oven (105 ºC), grounded into powder for sugar and proximate analyses. Second portion was placed in a sealed container and stored at -20 ºC prior to polyphenol analysis.

2.4 Determination of Proximate Contents

Moisture content was determined by oven-drying method at 105 ºC. Dried fruit samples were cut into small pieces and dried to a constant weight at 105 ºC overnight and were transferred to desiccators to cool. The moisture content was determined by the difference in sample weight before and after drying using the following calculation:

$$Moisture\ content\ (\%) = \frac{Weight\ of\ wet\ sample\ (g) - Weight\ of\ dried\ sample\ (g)}{Weight\ of\ wet\ sample\ (g)} \times 100\% \quad (1)$$

Total ash content was determined using the dry ashing method as described by AOAC (1997). The crucible containing dried sample was heated on hotplate until its turn into black and no more white fumes produced. Heated sample was placed in a muffle furnace at 550 ºC overnight and allowed to cool down in desiccators before weighing. Total ash content was determined by the difference in weigh before and after heating using the following calculation:

$$Total\ ash\ content\ (\%) = \frac{Weight\ of\ crucible\ (with\ ash) - Weight\ of\ crucible}{Weight\ of\ dried\ sample} \times 100\% \quad (2)$$

Crude fat content was estimated using the Soxhlet method as described by AOAC (1997). Dried sample was placed into a thimble and 70 ml of petroleum ether was added into the extraction cup. Following extracting out the fat from samples using Soxtec System HT6, the extraction cups were then dried in the drying oven for 15 minutes and transferred to desiccators to cool. The crude fat content was determined by the difference in weighing the extraction cup before and after extraction using the following calculation:

$$Crude\ fat\ content\ (\%) = \frac{Weight\ of\ extraction\ cup\ (before) - Weight\ of\ extraction\ cup\ (after)}{Weight\ of\ dried\ sample} \times 100\% \quad (3)$$

Crude protein content was determined by Kjeldahl method as described by AOAC (1997). Potassium sulphate (7 g) and copper sulphate (2 g) were added into digestion tube containing sample. Concentrated sulphuric acid (12 ml) was then poured into the tube and heated in Tecator Digestion System for 1 hour until solution turned to greenish blue in color. Distilled water (75 ml) was mixed with sample in the digested tube before distillation and boric acid (25 ml) as receiver. The distilled solution was then titrated with 0.2 M hydrochloric acid until it turned into light pink solution. The crude protein content was then determined using following calculation:

$$Nitrogen\ content\ (\%) = \frac{Volume\ of\ HCl\ used\ (Sample - Blank) \times N\ HCl \times 14.007}{Weight\ of\ dried\ sample\ (g)} \times \frac{100}{1000}$$

$$Protein\ content\ (\%) = Nitrogen\ content\ (\%) \times 6.25 \quad (4)$$

where, 6.25 is the nitrogen conversion factor for foods other than cereal, legumes, milk and milk products.

Total carbohydrate content was determined using difference method by AOAC (1997). Sum of moisture content, total ash, crude protein and fat contents will be subtracted by 100% as follow:

$$Total\ carbohydrate\ (\%) = 100\% - [Moisture\ content\ (\%) + Total\ ash\ (\%) + Crude\ protein\ (\%) + Crude\ fat\ (\%)] \quad (5)$$

2.5 Determination of Mineral Contents

Mineral content in dried fruit samples were determined using Atomic Absorption Spectrophotometer (AAS) by AOAC (1997). Hydrochloric acid (7 ml) was added into the crucible containing ash and was placed on the boiling water until dried. Dried sample ash was then mixed with hot deionized water, filtered into 100 ml conical flask and marked up with deionized water. Stock solutions were analyzed by using AAS. Mineral content was determined by using the following calculation:

$$Mineral\ content\ (ppm) = \frac{Concentration\ (ug/ml) \times Volume\ of\ stock\ solution\ (ml) \times Dilution\ factor}{Weight\ of\ dried\ sample\ (g)} \quad (6)$$

2.6 Determination of Polyphenol Content

The extraction of wet sample was carried according to method by Velioglu et al. (1998). Dried fruit sample (2 g) was mixed with 70% methanol (50 ml) and incubated in water bath shaker (70 ºC, 150 rpm) for 2 hours. The extract was then filtered and kept at -20 ºC until analysis.

Polyphenol content of dried fruit extracts was determined using the Folin-Ciocalteu method as described by Zhang et al. (2006). The extracts (20 µl) and Folin-Ciocalteu reagents (100 µl) were mixed into 96-wellplate flat bottom and waited for 5 minutes before mixing it with 7.5% of sodium carbonate (80 µl). The 96-wellplate was kept in the dark at room temperature for 2 hours and its absorbance was measured at 750 nm using microplate reader (iMark, Bio-Rad, Canada) and distilled water as blank. The results were expressed as mg gallic acid equivalent per 100 grams.

2.7 Determination of Total Sugar Content

Extraction of total sugar content from sample

Dried samples (5 g) were mixed with 40 ml of 80% ethanol and were refluxed for 1 to 2 hours. The mixture was filtered, and the ethanol was removed using rotary evaporator. The filtered mixture was filtered again into 100 ml conical flask and marked up with distilled water. Total sugar content was determined using the Dubois method as described by Dubois et al. (1956). The filtered sugar solution (1000 µl) was mixed with 1000 µl of phenol in the test tube. Sulphuric acid (5 ml) was then put into test tube, mixed well and kept it for 15 to 30 minutes. The absorbance was measured at 490 nm with spectrophotometer using distilled water as blank. Total sugar content was determined by using calculation as follow:

$$Total\ sugar\ content\ (\mu g/g) = \frac{Value\ from\ standard\ curve \times Volume\ of\ solution \times Dilution\ factor}{Volume\ of\ sample\ used\ for\ measurement \times Weight\ of\ dried\ sample} \quad (7)$$

2.8 Statistical Analysis

The data collected were analyzed using IBM SPSS for Windows version 22.0. Independent T test and one-way ANOVA was used to compare polyphenol and nutrient contents between different types of dried fruits. Results were expressed as mean and standard deviation with P value of < 0.001 was considered to be statistically significant.

3. Results

3.1 Nutrient Compositions in Dried Fruits

Nutrient content in selected dried fruits are shown in Table 1. Dried apricot contained significantly ($p < 0.001$) highest moisture (35.26%) and total ash (4.54%) contents while both Safawi (22.09%) and Mariami (21.6%) dates exhibited lower moisture content. Dried fig contained highest crude protein (3.93%) and fat (4.02%) contents. However, there was no significant difference ($p > 0.05$) in fat content for all three types of dates. Total carbohydrate content in dried fruits samples ranged from 56.09 to 72.81%.

Table 1. Nutrient contents in selected dried fruits

Dried fruit samples	Moisture (%)	Total ash (%)	Crude protein (%)	Crude fat (%)	Total carbohydrate (%)
Ajwa dates	27.10±2.17^{a}	2.79±0.12^{a}	3.13±0.52^{a}	0.14±0.02^{a}	66.84±2.40^{a}
Safawi dates	22.09±2.34^{c}	2.45±0.30^{a}	2.57±0.25^{a}	0.09±0.02^{a}	72.81±2.49^{b}
Mariami dates	21.68±1.22^{c}	2.99±0.39^{a}	2.93±0.19^{a}	0.17±0.04^{a}	72.24±1.61^{b}
Golden raisin	27.01±2.66^{a}	2.92±0.40^{a}	3.13±0.36^{a}	0.36±0.08^{a}	66.58±2.87^{a}
Black raisin	29.71±4.19^{a}	2.94±0.36^{a}	3.66±0.40^{b}	1.13±0.25^{b}	62.56±4.38^{ac}
Dried apricot	35.26±1.93^{b}	4.54±0.57^{b}	3.78±0.51^{a}	0.33±0.03^{a}	56.09±1.76^{d}
Dried fig	30.86±3.12^{ab}	3.79±0.21^{c}	3.93±0.39^{c}	4.02±0.58^{c}	57.36±3.89^{c}

Note. Data are expressed as mean±standard deviation. Different letters in the same column showed significant difference ($p < 0.001$) with One-way ANOVA test.

3.2 Total Polyphenol Content of Dried Fruits

Total polyphenol content of dried fruits is as shown in Table 2. Golden raisin showed the significantly highest total polyphenol content (562.15 mg GAE/100 g) compared to other dried fruits ($p < 0.001$). However, dried fig was lower in polyphenol content (151.04 mg GAE/100 g). There was no significant difference ($p > 0.05$) for polyphenol content between black raisin and Mariami dates.

Table 2. Total polyphenol content (mg GAE/100 g) in selected dried fruits

Dried fruits selected	Total polyphenol content (mg GAE/100 g)
Ajwa dates	387.71±42.50^{a}
Safawi dates	373.74 ±50.10^{a}
Mariami dates	308.98±42.15^{bc}
Golden raisin	562.15±37.01^{d}
Black raisin	271.67±29.40^{c}
Dried apricot	354.61±43.44^{ab}
Dried fig	151.04±18.91^{e}

Note. Data are expressed as mean±standard deviation. Different letters in the same column showed significant difference ($p < 0.001$) with One-way ANOVA test.

Mineral content in selected dried fruit sample are as shown in Table 3. Dried fig showed the highest amount of calcium (Ca) (287.27 mg Ca/100 g) and magnesium (Mg) (72.67 mg/100 g). However, Ajwa dates (53.67 mg Ca/100 g) and golden raisin (55.59 mg Ca/100 g) contained lower Ca contents. Dried apricot exhibited high content of iron (Fe) (2.72 mg Fe/100 g) and potassium (K) (1044.49 mg K/100 g). Result showed that Fe content in three types of date samples were ranging from 0.93 to 0.96 mg Fe/100 g. Dried fig and Mariami dates exhibited highest zinc (Zn) contents with the value of 0.52 mg Zn/100 g.

Table 3. Mineral content (mg/100 g) in selected dried fruits

Dried fruit selected	Ca (mg/100 g)	Fe (mg/100 g)	Mg (mg/100 g)	K (mg/100 g)	Zn (mg/100 g)
Ajwa dates	53.67±3.79^{a}	0.96±0.04^{a}	47.05±3.09^{a}	759.44±69.27^{ab}	0.45±0.02^{a}
Safawi dates	57.13±3.79^{a}	0.93±0.04^{a}	45.04±3.09^{a}	695.00±69.27^{b}	0.43±0.02^{a}
Mariami dates	71.34±6.04^{a}	0.95±0.05^{a}	49.33±1.42^{a}	868.70±55.84^{ab}	0.52±0.02^{b}
Golden raisin	55.59±10.81^{a}	1.86±0.09^{b}	31.62±2.91^{b}	847.77±75.42^{ab}	0.32±0.02^{c}
Black raisin	77.31±6.98^{a}	1.64±0.13^{c}	30.15±5.41^{b}	741.28±79.21^{ab}	0.22±0.02^{d}
Dried apricot	68.11±7.02^{a}	2.72±0.04^{d}	31.71±6.35^{b}	1044.49±171.36^{c}	0.43±0.02^{a}
Dried fig	287.27±52.20^{b}	2.04±0.04^{e}	72.67±3.27^{c}	780.06±112.76^{ab}	0.52±0.02^{b}

Note. Data are expressed as mean±standard deviation. Different letters in the same column showed significant difference ($p < 0.001$) with One-way ANOVA test.

3.3 Total Sugar Content in Dried Fruits

Total sugar content in selected dried fruit samples are as shown in Table 4. Ajwa, Safawi and Mariami dates showed significantly ($p < 0.001$) highest total sugar content of 43.75, 46.43 and 48.61%, respectively, when compared to other types of dried fruits. Dried apricot has lowest total sugar content with the value of 10.35%. Table 5 summarized the overall nutrient content in selected dried fruits based on per serving for easy comparison.

Table 4. Total sugar content (g/100 g) in selected dried fruits

Dried fruit selected	Total sugar content (%)
Ajwa dates	43.75 ± 2.64^{ab}
Safawi dates	46.43 ± 1.88^{a}
Mariami dates	48.61 ± 0.71^{a}
Golden raisin	37.32 ± 3.59^{bc}
Black raisin	34.11 ± 3.75^{c}
Dried apricot	10.35 ± 0.47^{d}
Dried fig	23.39 ± 2.22^{e}

Note. Data are expressed as mean±standard deviation. Different letters in the same column showed significant difference ($p < 0.001$) with One-way ANOVA test.

Table 5. Information on origin and nutrient content in selected dried fruits based on per serving size

Dried fruits (Scientific Name)	Ajwa Date (*Phoenix dactylifera*)	Safawi Date (*Phoenix dactylifera*)	Mariami Date (*Phoenix dactylifera*)	Golden Raisin (*Vitis vinifera* L.)	Black Raisin (*Vitis vinifera* L.)	Dried Apricot (*Prunus armeniaca* L.)	Dried Fig (*Ficus carica* L.)
Origin	Saudi Arabia	Saudi Arabia	Iran	Iran	Iran	Turkey	Turkey
Serving Size (g)	30	30	30	25	25	30	30
Energy (kcal)	84	91	91	71	69	73	85
Fat (g)	0.04	0.03	0.06	0.09	0.28	0.10	1.21
Protein (g)	0.94	0.77	0.88	0.78	0.92	1.13	1.18
Carbohydrate (g)	20.05	21.84	21.67	16.65	15.64	16.83	17.21
Total Sugar (g)	13.13	13.93	14.58	9.33	8.53	3.11	7.08
Calcium (mg)	16.10	17.14	21.40	13.90	19.33	20.43	86.18
Iron (mg)	0.29	0.28	0.29	0.47	0.41	0.82	0.61
Magnesium (mg)	14.12	13.51	14.80	7.91	7.54	9.51	21.80
Zinc (mg)	0.14	0.13	0.16	0.08	0.06	0.13	0.16

4. Discussion

Four types of dried fruits analyzed in this study were dates (Ajwa, Safawi and Mariami dates), raisins (golden and black raisins), dried apricot and fig. Dried apricot showed the highest total ash content of 4.54% which agreed with the study by Hussain et al. (2010) who reported apricot containing 4.86% ash content. High percent of ash content is an indication of high mineral content. However, USDA database reported lower total ash content in dried apricots (2.60%). There are a few factors such as drying technique, cultivar and nutrient determination that can affect the total ash, protein and fat contents (Nasir et al., 2015). Apricots varieties and location of plantation are important factors that influence the nutrient and mineral contents (Martin-Belloso & Llanos-Barriobero, 2001). Dried fig showed the highest crude protein (3.93%) and fat contents (4.02%). The fat content in dried fig have been reported to be 0.56% (Soni et al., 2014) and 1% (USDA), which were lower as compared to this study.

Golden raisin in this study showed highest total polyphenol content compared to other dried fruits. Breksa et al. (2010) has reported that golden raisin contained total polyphenol of 357.70 mg GAE/100 g, which was similar to this study. The polyphenol content in black raisin (271.67 mg GAE/100 g) was reported to be much lower compared to golden raisin. Golden raisins have higher total polyphenol content compared to other types of raisins based on data from USDA and PhenolExplorer (Williamson & Carughi, 2010). In addition, dried fig has

lower content of polyphenol. Dried fig contained significantly ($p < 0.001$) higher amount of calcium (287.27 mg Ca/100 g) and magnesium (72.67 mg Mg/100 g). Dried figs have been reported to be a very important source of vitamins, minerals, carbohydrates, sugars, organic acids and phenolic compounds (Jeong & Lachance, 2001; Veberic et al., 2008; Slatnar et al., 2011). Dried figs are rich in dietary fiber, vitamin K and minerals such as magnesium, potassium and calcium (Vinson, 1999). Ajwa dates (53.67 mg Ca/100 g) and golden raisin (55.59 mg Ca/100 g) contains lower Ca contents. Dried apricot exhibited high content of ferum (2.72 mg Fe/100 g) and potassium (1044.49 mg K/100 g). Both dried fig and Mariami dates exhibited the same highest amount zinc content (0.52 mg Zn/100 g).

Ajwa, Safawi and Mariami dates showed the highest total sugar content ranging from 43.75 to 48.61%. Total sugar content in these types of dates has been previously reported to be ranging from 55.27 to 57.36% (Assirey, 2015). Dried apricot in this study contained significantly ($p < 0.001$) lowest total sugar content (10.35%) compared to other dried fruit samples. The value was almost equal to Hussain et al. (2010) study that reported dried apricot in Pakistan contained 13.39%. In addition, USDA also reported almost the same amount of total sugar (19.57%) as compared to our studied samples.

Based on Guide to Nutrition Labelling and Claims (MOH, 2010), three types of selected dates (45.04-47.05 mg Mg/100 g) and dried fig (72.67 mg Mg/100 g) were source of Mg since it contained more than 15% of the Nutrient Reference Value (NRV) of Mg (300 mg). In addition, the selected dried fruits in this study containing 0.09-1.13% fat except for dried fig (4.02%) which was considered fat-free. This was due to the fat content was less than 3%. Dried apricot (2.72 mg Fe/100 g) was a good source of Fe, containing more than 15% of NRV of Fe (14 mg) while dried fig (287.27 mg Ca/100 g) was rich in Ca, containing more than 15% of NRV for Ca (800 mg).

5. Conclusion

Findings from this study showed that dates, raisins, dried apricot and dried fig contained low amount of protein and fat. Dried figs are a good source of magnesium and calcium while dried apricots are rich in iron. All three types of dates contained highest total sugar content while dried apricot showed lowest total sugar content. Golden raisins exhibited high total polyphenol content. Further research should be conducted to find out the amount of individual sugars in selected dried fruits and analyzing all types of dried fruits available in Malaysia to update the data in MyFCD.

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