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Reduction in oxalate content during the preparation of a traditional Tongan dessert

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Abstract

A traditional Tongan dessert is made from two plants which commonly grow in the Tongan group of islands. Taro (*Colocasia esculenta* var. Schott) leaves and starch prepared from cassava (*Manihot esculenta* Crantz) tubers are the two main ingredients. In this study, the dessert which is called Faikakai Ngou'a in Tongan, was prepared from locally grown freshly harvested taro (cv. Maori) leaves using simple domestic kitchen methods. The dark green heart-shaped taro leaves have a bitter taste and contain high levels of oxalate that can be eliminated by cooking and processing. Raw taro leaves contained 6.48±0.06 g total oxalate kg^{-1} fresh weight (FW), 49% as soluble oxalate. In this study the oxalate content of the cooked product was significantly lower than that of the original taro leaves. Faikakai Ngou'a contained 2.80±0.06 g total oxalates kg^{-1} FW, of which 12% were soluble. Soluble oxalate was removed in the cooking water and the total oxalate content of the final product was also reduced by dilution following the addition of cassava starch. The final product retained the essential taste and acceptable brown-black green colour (CIE colour values L* 25.18±0.33, a* -2.87±0.04, b* 5.76±0.09) of taro leaves without the background content and sharp taste of oxalate. The final product had a firm, non-sticky texture that was acceptable to Tongan consumers.

Key words: Taro leaves, *Colocasia esculenta* var. Schott, soluble oxalate, insoluble oxalate, proximate analysis, CIE L*a*b* colour values, cooking.

Introduction

In Tonga and many Pacific Islands taro (*Colocasia esculenta* var. Schott) leaves are cooked and eaten in a number of different ways. There are no recipe books describing how to prepare traditional Tongan food although a description of the culture and ideas surrounding Tongan food has been published [1]. As there are no written recipes, people learn to make different foods by watching their parents or experts in the community making them. A traditional Tongan dessert (called Faikakai Ngou'a in Tongan) is prepared for special occasions. It is made from two plants which commonly grow in the Pacific Islands. The two main constituents, taro leaves and cassava (*Manihot esculenta* Crantz) tubers, each need to be processed in quite different ways following harvesting. As cassava tubers contain free and bound cyanogenic glucosides which are converted to cyanide in the presence of linamarase, considerable care needs to be taken to peel and process these tubers to produce the starch as a dry powder. More recently, imported cassava flour (tapioca flour) has considerably simplified preparation of traditional Tongan foods.

Taro leaves contain high levels of oxalate which give the raw leaves a sharp taste [2, 3]. Raw taro leaves contain high levels of oxalate comparable with spinach and Swiss chard [4, 5]. The oxalate composition of taro leaves has ranged from 4.26 g total oxalate kg^{-1} fresh weight (FW) for taro leaves grown in Fiji [2] to 5.24 g total oxalate kg^{-1} FW for taro leaves grown in the spring in Pukekohe (south of Auckland), N.Z. [7]. However, younger taro leaves contained a mean of 5.89 g total oxalate kg^{-1} FW compared to 4.43 g total oxalate kg^{-1} FW for mature leaves grown in a greenhouse in Christchurch [8]. Soaking the leaves in cold water for 30 minutes prior to cooking results in a 6% loss of soluble oxalates, while boiling the leaves leads to a 36% reduction [6]. Pouring away the cooking water removes soluble oxalate and also improves the taste of the final product. Removing of moisture from the cooked taro leaves is an essential step in the successful manufacture of Faikakai Ngou'a.

There is considerable pride involved in making Faikakai Ngou'a. It should have a brown-black green colour, a firm texture, should not be sticky to touch and should have a distinctive taro flavour. Faikakai Ngou'a is cut into slices or small squares and the Lolo sauce (a caramel sauce made from brown sugar and coconut milk) added. It is eaten as a dessert. As Faikakai Ngou'a is usually made the day before a special occasion so there is no interest in storage for future consumption. Experienced Faikakai Ngou'a cooks take into account the differing composition of the leaves (whether they are freshly harvested or wilted or young or old leaves) by changing the cooking times and amount of cassava starch added to the cooked taro leaves. Traditional manufacture involves the use of simple utensils and hands alone to mix the

food. Originally, the final mix would have been wrapped in banana leaves and cooked in an Umu, an earth oven. This study describes the preparation of this special food using simple utensils and the chemical analysis of the final product.

Materials and Methods

Harvesting: Young and mature taro (*Colocasia esculenta* var. Schott, cv. Maori) leaves were harvested in May 2006 (autumn in New Zealand) from a plastic tunnel house greenhouse run by a Tongan Community Trust (Kahoa Tahoa Tauleva Christchurch Trust) situated at the Waio-ora Trust, Harewood, Christchurch, New Zealand, (172°34'E, 43°29'S) 21 m above sea level. The plants were grown on Templeton silty loam soil without any applications of fertiliser. The stems were discarded and the harvested leaves were placed in a plastic bag and stored at 4ºC until they were cooked. Tapioca flour was purchased from an Asian supermarket (Sun Tai Holdings Ltd, Christchurch, N.Z.) and was imported from Thailand.

Preparation of Faikakai Ngou'a: Five hundred g of raw leaves were washed in cold water and the damaged parts were discarded. The leaves were boiled in tap water for 15 minutes in a saucepan. Excess water was removed from the cooked leaves as much as possible before they were spread on a tray, coarsely chopped and allowed to cool. Sugar and tapioca flour were slowly added to the mixture while mixing with a spoon until there were no lumps in the mixture. The mixture was then placed in a polythethylene bag (Glad Oven Bags, 250 mm x 400 mm x 1.6 µm, Clorox New Zealand Ltd, Mt Wellington, Auckland), sealed with a twist tie and boiled in water for 45 minutes. The Faikakai Ngou'a was ready when it had a brown-black green colour. It was allowed to cool to room temperature before it was sliced. This process was not straightforward and several attempts were made before the correct consistency was achieved, a limitation of not having a written recipe.

Proximate analysis: Moisture, protein, ash, total fibre and fat contents of three separate samples of fresh taro leaves and freshly prepared Faikakai Ngou'a were determined by routine analysis [9].

Determination of total and soluble oxalate: Soluble and total oxalate of 5 g of fresh taro leaves and freshly prepared Faikakai Ngou'a was extracted and measured as described in detail by Savage *et al.* [5]. Insoluble oxalate content (calcium oxalate) was calculated by difference [2]. Each sample was analysed in triplicate and all data are presented as g oxalate kg^{-1} fresh weight (FW).

Colour: The CIE coordinates, L*(lightness, 0 = black, 100 = white), a* (-a* = greenness, +a* = redness) and b* (-b* = blueness, +b* = yellowness) were measured on the raw leaves and cooked Faikakai Ngou'a using a Minolta Chroma Meter (model CR-210, Minolta Camera Co. Ltd. Osaka, Japan). The chromameter consisted of an 8 mm diameter measuring area and diffuse illumination/0° viewing was used, and the readings were calibrated against a standard white tile. Each sample was measured four times.

Results

The mean proximate analysis of fresh taro leaves and Faikakai Ngou'a are shown in Table 1. The fresh leaves contained 11.5±0.38 g dry matter (DM)/100 g FW after boiling for 15 minutes. After squeezing some excess moisture from the cooked leaves, the dry matter of the cooked leaves was 10.2±0.52 g DM/100 g FW. Following addition of the tapioca flour the dry matter of the mixed Faikakai Ngou'a prior to final boiling was 35.8±0.32 g DM/100 g FW.

The total, soluble and insoluble oxalate of the fresh taro leaves and freshly prepared Faikakai Ngou'a are shown in Table 2. The mean total oxalate of the Faikakai Ngou'a (2.80±0.06 g total oxalate kg^{-1} FW) was much lower than the leaves used to make it (6.48±0.06 g total oxalate/100 kg^{-1} FW) In the process of making Faikakai Ngou'a soluble oxalates appeared to be lost in the water drained from the cooked leaves. In the taro leaves the water soluble oxalates were 49% of the total oxalates, in contrast, the mean water soluble content of the Faikakai Ngou'a was 12%.

The mean CIE colour values for raw dark green heart-shaped taro leaves and cooked Faikakai Ngou'a are shown in Table 3. The L* value confirms that the cooked Faikakai Ngou'a was quite dark (0 = black) while the a* value shows the sample had an overall brown-black green colour.

Discussion

Proximate analysis showed that Faikakai Ngou'a is a high carbohydrate food, with the carbohydrate, the starch fraction, essentially coming from the added tapioca flour. The fat, fibre and protein in this food come from the taro leaves and are very low in Faikakai Ngou'a.

The oxalate content of the leaves harvested in autumn 2006 for this study (Table 2) contained 6.48 g total oxalate kg^{-1} FW. This is 30% higher than the values reported for taro grown in New Zealand in previous years. The result in Table 2 is similar to the values for younger leaves (5.89 g kg^{-1} FW) grown previously in New Zealand [8]. The leaves used in this study were a mixture of young and mature leaves. The water soluble oxalate was 49.2% of total oxalate and the insoluble oxalate was 50.8% of total oxalate.

The total oxalate of the Faikakai Ngou'a (2.80±0.06 g total oxalate kg^{-1} FW) was much lower than that of the leaves used to make it. In the process of making Faikakai Ngou'a soluble oxalate was lost in the water that drained away from the cooked leaves. In addition, during manufacturing of the Faikakai Ngou'a the taro leaves were cooked and mixed with tapioca flour and sugar which made up 21% of the final product. The added tapioca flour effectively dilutes the remaining oxalate in the final product as tapioca flour contains no oxalate.

It is interesting to note that the soluble oxalate of the Faikakai Ngou'a was reduced to 12% of the total oxalate while the insoluble oxalate was 88% of the total oxalate. This confirms that soluble

Table 1. Mean proximate analysis of taro leaves and Faikakai Ngou'a (mg/100 g FW ± SE).

	Moisture	Ash	Fat	Protein	Total fibre (ADF)	Carbohydrates (by difference)
Taro leaves	88.5 ± 0.38	1.53 ± 0.01	0.57 ± 0.02	2.96 ± 0.01	2.13 ± 0.02	4.31
Faikakai Ngou'a	64.2 ± 0.32	0.90 ± 0.01	0.63 ± 0.01	3.19 ± 0.03	1.45 ± 0.15	29.7

Table 2. Mean oxalate content in taro leaves and Faikakai Ngou'a (g kg^{-1} FW ± SE).

	Total oxalate	Soluble oxalate	Insoluble oxalate[1]
Taro leaves	6.48 ± 0.06	3.19 ± 0.09	3.29 ± 0.07
Faikakai Ngou'a	2.80 ± 0.06	0.33 ± 0.05	2.48 ± 0.03

[1] Insoluble oxalate = (total oxalate - soluble oxalate) [2].

Table 3. Mean CIE L*a*b* colour values of the Taro leaves and Faikakai Ngou'a (mean ± SE).

	L*	a*	b*
Taro leaves	32.49 ± 0.71	-11.68 ± 0.93	12.06 ± 1.04
Faikakai Ngou'a	25.18 ± 0.33	-2.87 ± 0.04	5.76 ± 0.09

oxalate was lost during manufacture of the Faikakai Ngou'a. Soluble oxalate was lost as excess moisture was squeezed from the cooked taro leaves, but it is also possible that some of the remaining soluble oxalate in the cooked taro leaves combined with calcium (to make insoluble oxalate) in the tapioca flour during the second cooking process. Overall these two processes make Faikakai Ngou'a a safer product to eat from the point of view of the soluble oxalate content of the food. It has been suggested that insoluble oxalate (calcium oxalate) in food is not a problem as it is not absorbed into the body as the food passes down the intestinal tract [8]. The method used in this study showed that Faikakai Ngou'a can be made at home using simple cooking utensils. Boiling the final mixture in a polyethylene bag is, however, a modern adaptation. The most important features of making Faikakai Ngou'a are to get the ratio of leaves to tapioca in the correct proportion and remove sufficient water in the final stages so that the final product is dry enough. A Tongan family who tasted the products confirmed that the colour, texture and taste of the cooked Faikakai Ngou'a was very acceptable.

Conclusions

In this study a traditional Tongan dessert was prepared from freshly harvested taro (cv. Maori) leaves using simple home based methods. In the process, the oxalate content of the cooked product contained significantly less oxalate than the original taro leaves. Faikakai Ngou'a is an unusual dessert, where the colour, taste and texture are the most important features. It is not a food which supplies essential nutrients; it is a special dessert made to celebrate special occasions.

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