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Effect of Different Pre-treatments and Frying Process on Proximate, Some Essential Minerals, and Anti-nutritional Factors of Taro Found in Birjung, Nepal

Shristi Poudel Sharma[1], Bishal Thagunna[2,*], Rosy Baral[2], Rashmi Baral[2], Deepa Khadka[1]
[1]Department of Food Microbiology, [2]Department of Food Technology, Tribhuvan University, Pokhara, Kaski, Nepal.

Corresponding author*
bisu.thaguna123@gmail.com

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Abstract

Taro corms (Colocasia Esculenta), also called *pindalu* in Nepalese society are exposed to different pretreatment such as boiling in plain water at 100ºC for 7min, boiling in 1.2% salt solution at 100ºC for 7min, boiling in 5% citric acid100ºC for 7min and frying was investigated for proximate, antinutritional and mineral content. The proximate composition of raw taro corms was found to be moisture 60.82%, crude fat 0.96%, crude protein 9.69%, total ash 3.77%, crude fiber 3.49% and carbohydrate 52.0%. Macro nutrients such as Potassium, Calcium, Phosphorous, and Sodium were found to be 620.55 mg/100g, 150.12 mg/100g, 53.72 mg/100g, and 36.62 mg/100g, respectively. Antinutritional factors of raw taro corms analyzed in this study were oxalate-280.98±0.49 mg/100g, phytate-84.90±0.74 mg/100g and tannin-47.67±0.11 mg/100g. Potassium was the most abundant macro mineral (620.55mg/100g) in the unprocessed taro corms. The effect of pretreatments and frying on calcium showed significant decrease. When compared with raw taro corms, pretreatments and frying process resulted in a significant increase in phosphorous and sodium content. Antinutritional factors were significantly reduced by the pre-treatments, and frying method appears to be more effective in reducing phytate and tannin, whereas boiling in 5% salt solution for oxalate content.

Keywords: Colocasia Esculenta; macro-nutrient; boiling; frying; anti-nutrients.

INTRODUCTION

Taro, or cocoyam, is the common name for an edible corm that belongs to the *Araceae* family, which plays an important role in food security in many developing countries and regions of the subtropics and tropics of the world. The term taro is usually used to indicate *Colocasia esculenta* (L.) (Saleh, 2019). Nutritionally, the taro corms are considered source of starch easily digestible, also contain- significant levels of protein, thiamine, riboflavin, niacin and vitamin C (John et al., 2007). Typically, the nutritional value of food is influenced by the levels of nutrients present, how effectively these nutrients can be utilized, and the existence or non-existence of anti-nutritional substances and harmful factors (Alcantara et al., 2013). Similar to many plant-based foods, taro has a range of antinutritional and toxic substances, including oxalates, phytates, trypsin and amylase inhibitors, tannins, and cyanide (Adane et al., 2013). To minimize the impact of anti-nutrients, which can pose certain health risks, it is important to process foods appropriately before eating. Cooking enhances digestibility, increases palatability, extends shelf life, and also ensures that root vegetables are safer for consumption (Azene and Molla, 2017).

Oxalate can decrease the availability of minerals; a higher concentration of oxalate can bind to the calcium found in food, making it unavailable for its essential physiological and biochemical functions, such as supporting strong bones and teeth, acting as a cofactor in enzymatic reactions, facilitating nerve impulse transmission, and serving as a clotting factor in the blood. Insoluble calcium oxalate may also accumulate in soft tissues, such as the kidneys, leading to the formation of kidney stones. The reduction of calcium can result in the deterioration of bones and teeth as well as disrupt the blood clotting process (Ayele et al., 2015).

Phytate has been identified as an antinutrient because of its negative effects. It decreases the bioavailability of minerals and leads to inhibited growth. Phytate creates insoluble complexes with Cu^{2+}, Zn^{2+}, Fe^{3+}, and Ca^{2+}, consequently diminishing the availability of these vital minerals. Studies involving animal feed with plant-based diets indicate that the reduced bioavailability of Zn, Ca, Mg, P, and Fe is due to the presence of phytate. Notably, deficiencies in Zn and Fe have been reported as a result of high phytate consumption (Greiner and Konietzny, 2006; Greiner et al., 2006).

Another factor that negatively affects nutrition in taro is tannin. Tannin is a water-soluble compound with a high molecular weight that significantly impacts nutritional values. It possesses unique characteristics, such as the ability to precipitate proteins, alkaloids, and gelatins. Foods that are high in tannins are regarded as having low nutritional value because they cause the precipitation of proteins and hinder digestive enzymes and reabsorption. Additionally, it affects the utilization of vitamins and minerals in meals (Azene and Molla, 2017).

MATERIALS AND METHOD

Sample Collection

7 kg of fresh taro corms required for the preparation of chips were collected from the local market of Birgunj, Nepal. The less acrid local variety known as *kharipindalu* was selected as raw materials for the chip's preparation. Corms were then cleaned and sorted to remove dust, foreign matter and damaged parts. Taro corms of almost uniform size were selected for further processing and stored at low temperatures.

Determination of proximate composition

The moisture, crude fat, crude fiber, and ash content of the raw taro were analyzed using the procedure outlined by (AOAC, 2006). The protein level was assessed with the micro Kjeldahl method (N x 6.25), while the carbohydrate content was derived by subtraction.

Methodology

Sample preparation

The taro corms were cleaned and peeled with a stainless-steel knife, and any undesirable sections were discarded. Additionally, taro corm slices were produced using a hand slicer in the kitchen. The slices were rinsed with cold water for three minutes to eliminate any mucus and other substances before draining the excess water. The obtained taro slices were further divided into three treatments: (a) boiling in plain water at 100ºC for 7 min, (b) boiling in citric acid 1.2% at 100ºC for 7 min, and (c) boiling in salt solution 5% at 100ºC for 7 min (d) frying at 180 ºC until crisp and a golden brown respectively (Kumar et al., 2017).

Determination of anti-nutrients

Determination of oxalate content

The oxalate content of samples was determined as described by (Onwuka, 2005). The procedure involves three steps: digestion, oxalate precipitation and permanganate titration.

Determination of tannin

Tannin content was determined using the method by (Atanassova and Christova, 2009).

Determination of phytate

Phytate content was determined as described in (Azene and Molla, 2017)

Statistical analysis

All the experiments were performed in triplicate. The result was evaluated by using analysis of variance using statistical software SPSS V20 and MS Excel 2016 at 5 % level of significance.

RESULT AND DISCUSSION

Table 1. Proximate composition of selected raw taro corm.

Parameters	Value (%)
Moisture	60.82±0.51
Crude fat	0.96±0.61
Crude protein	9.69±0.52
Total ash content	3.77±0.10
Crude fiber	3.49±0.24
Carbohydrate	52.0±1.30

Values are means ± standard deviation of triplicate analysis.

The moisture content, crude fat, crude protein, ash content, crude fiber, and carbohydrates were measured at (60.82, 0.96, 9.69, 3.77, 3.49, and 52.0) %, respectively as shown in Table 1. (Azene, 2017) reported that the moisture content of fresh raw taro was 67.64, which is somewhat slightly higher than the findings mentioned above. (Beno et al., 2022) discovered that the moisture content of tannia cocoyam was 72.91 %, which is relatively higher than the above study. Likewise, (Adane et al., 2013) indicated a moisture content of 80.02%, which is significantly higher than the results presented earlier. A research study by (Azene, 2017) identified the crude fat, crude protein, ash content, and crude fiber levels as (0.67, 6.62, 3.92, 5.8) %. When compared to the table mentioned above, the ash content was noted to be higher, whereas the other parameters were slightly lower than the figures presented in the table. According to (Kumar et al., 2023), the levels of crude fat, crude protein, ash content, crude fiber, and carbohydrates were recorded at (0.90, 4.0, 4.92, 2.84, and 75.90) %. In comparison to the table above, the ash content, fiber, and carbohydrate content were observed to be higher, while the remaining parameters were lower than the previous results.

Table 2. Antinutritional content of raw, treated, and fried taro chips.

Antinutritional factors	A	B	C	D	E
Oxalate	280.98±0.49	128.76±0.12	82.09±0.77	69.61±0.12	150.22±0.66
Phytate	84.90±0.74	80.32±0.12	76.45±0.25	76.45±0.25	70.77±0.49
Tannin	47.67±0.11	43.68±0.18	33.69±0.69	24.70±0.20	13.31±0.22

Values are means ± standard deviation of triplicate analysis.
Here A* raw, B* boiled in plain water, C* boiled in 1.2 % citric acid, D* boiled in 5% salt solution, and E* fried taro chips.

Oxalate

The content of oxalate of raw, plain water boiled, treated with 1.2% citric acid, treated with 5% salt solution and fried chips samples were (280.98, 128.76, 82.09, 69.61, 150.22) mg/100g. Raw taro corm had the highest oxalate content which then significantly decreased when processed into different treatments and fried (Table 2). Boiling in 5% salt solution at 100ºC for 7min, significantly reduced higher percentage of oxalate content as compared to the other samples. Similarly, boiling in a plain water and 1.2% citric acid solution at 100º C for 7 minutes also reduced oxalate concentration compared to frying technique. (Azene and Molla, 2017), also found that boiling methods successfully reduced the oxalate levels in the tuber under study. The greatest reduction in oxalate levels was observed when the raw taro corm was boiled. Boiling results in significant cell damage, which helps soluble oxalate seep into the cooking water, and this pattern was consistently noted across observations. Washing, peeling, dicing, and soaking are examples of treatment procedures that can lower the oxalate content before frying. Additionally, it was shown that heating decreased the oxalate concentration by 56.7% while soaking decreased it by 23.5%. The amount of oxalate in the samples significantly decreased after frying (Huang et al., 2007; Azene and Molla, 2017). Conversely, several studies have explored methods for pre-treating taro corm to lower its total oxalate levels. (Sefa and Agyir-Sackey, 2004) found that the most effective processing method for decreasing total oxalate levels in taro corm sections was drying using a drum dryer, which successfully reduced the oxalate content by approximately 50%. (Kumoro et al., 2014) discovered that soaking taro root chips in a 10% baking soda solution for 2 hours at room temperature was the most effective method for lowering calcium oxalate levels. The findings do not align with the data provided here, which is attributable to the varying methods employed to mitigate oxalate risk in taro corm. Consequently, the identified forms of oxalate varied.

Phytate

The phytate content of raw taro corms was 84.90 mg/100g. however, this result was lower as reported by (Adane et al., 2013) for raw taro in Ethiopia and (Huang et al., 2013), for cultivars of taro grown in Taiwan. Also, (Saleh, 2019), found that the phytic acid in raw taro chips was 161.16 mg/100 which is higher than the above result. (Kumar et al., 2005), generally found that the levels of phytic acid vary based on several key factors, including the variety, geographical location, climate, irrigation practices, soil characteristics (such as pH, temperature, and the availability of organic phosphorus), and the specific year of the crop. The data presented in Table (2) show phytate content of taro corm chips undergo three different treatments and frying processes. There were observed that significant differences among all three treatments and frying technique on the phytate content of raw taro corms. The above data also represented that frying process significantly reduced the phytic acid from 84.90 mg/100g to 70.77 mg/100g respectively. (Patterson et al., 2017) noted that soaking pulses in water led to a slight reduction in phytates when they examined how processing impacted various anti-nutritional components in different pulses. The extent of this reduction may vary based on the duration of the soaking period. (Saleh, 2019), soaked taro corm chips soaked for 60 min in solutions of different calcium salts and they found the treatments with calcium chloride at concentration 5% had the greatest effect. The treatment helped to reduced phytic acid from 161.16mg/100g to 133.68mg/100g. this result support the above table the salt treatment also reduce the phytic acid from 84.90 to 76.45 mg/100g. As noted by (Azene and Molla, 2017), the reduction in phytate levels during cooking methods like boiling or frying might be partially attributed to the creation of insoluble complexes involving phytate along with other elements such as protein or minerals associated with protein. Additionally, phytate might become soluble at extremely high temperatures, such as those reached during boiling (100°C) and baking (190°C), as indicated by the notable decrease in phytate levels observed during frying and boiling (Adane et al., 2013). Frying process was more effective on decreasing phytic acid content.

Tannin

Tannin is a water-soluble substance with a high molecular weight that significantly affects nutritional quality. It possesses unique characteristics, including the ability to cause the precipitation of alkaloids, gelatins, and proteins. Foods high in tannin is often regarded as having low nutritional value because they cause protein precipitation, hinder digestive enzymes, and affect nutrient reabsorption. It also impacts the absorption of vitamins and minerals from the diet (Tinko and Uyano, 2001; Azene and Molla, 2017). In this study the amount of tannin of raw taro corm was 47.67mg/100g which is lower than (Azene and Molla, 2017) study. From the result obtained in this study boiling in plain water, 1.2% citric acid, 5% salt solution and frying resulted in significant decrease in tannin and highest decrease observed in frying process from (47.67 to 13.31) mg/100g. this result agree with the findings of researchers done on effects of processing on antinutritional factors on taro cultivars (Akpan et al., 2004; Onu and Madubuike, 2006). Boiling treatments also lowered the tannin levels, which occurs because boiling might extract the hydrolysable tannins into the water (Richelle et al., 2013). This result is also supported by the (Lewu et al., 2010). The maximum safe tannin consumption for a male is 560 mg/kg (Stephene, 2004) Therefore, the tannin levels in the taro are minimal and fall within acceptable limits, making them safe for consumers (Stephene, 2004).

Table 3. Mineral content of raw, treated, and fried taro chips.

Components	A	B	C	D	E
Potassium (mg/100g)	620.55	480.78	492.16	498.06	350.52
Calcium (mg/100g)	150.12	145.20	143.12	142.10	110.22
Phosphorous (mg/100g)	53.72	56.23	57.12	58.03	58.05
Sodium (mg/100g)	36.62	42.82	45.55	50.56	48.23

Values are means ± standard deviation of triplicate analysis.
Here A* raw, B* boiled in plain water, C* boiled in 1.2 % citric acid, D* boiled in 5% salt solution, and E* fried taro chips.

Potassium

The presence of four macro minerals was examined in both processed and unprocessed taro. Potassium was found to be the most plentiful macro mineral (620.55mg/100g), while Calcium ranked as the second most prevalent mineral (150.12mg/100g) in unprocessed taro. Phosphorous was the third most abundant mineral observed in fried taro chips, amounting to 58.05mg/100g, and a significant quantity of sodium (50.56mg/100g) was also recorded in taro boiled in a 5% salt solution at 100 degrees for 7 minutes. The result indicated that raw taro corm when undergoing different treatments had a significant effect ($p \leq 0.05$) on the mineral content. (Godfrey et al., 2022), found the potassium, calcium, sodium and phosphorus content of raw yam 72.23 mg/100g, 190.57 mg/100g, 32.05 mg/100g and 193.1 mg/100g respectively. This value supported the above result except the value of potassium. Similarly, (Azene and Molla, 2017), investigated the mineral content of raw tubers and processed tubers and found that significant increase or decrease in mineral content by the processing technique. This result is also similar to the above result. Processed samples of raw taro corm showed significant differences from raw ones. This was also supported by the findings (Akpan et al., 2004). Generally, processing resulted in a significant rise in phosphorus levels, a finding corroborated by (Abera et al., 2013), which showed that the phosphorus content of taro significantly increased following boiling and fermentation. The mean concentration of sodium also showed a significant increase as a result of processing. This observation aligns with the work of (Azene and Molla, 2017), where boiling raised sodium levels, while fermentation reduced its concentration, in contrast to the current findings of this study. The frying process boosted the amounts of both sodium and potassium. The minor reduction in calcium levels during the boiling process can be attributed to water absorption and leaching that occur while boiling. There is a notable decrease in calcium and potassium levels during frying, which is caused by breakdown and chemical alterations such as oxidation, and some calcium and potassium may also be lost as volatile compounds, leading to this decline (Olajide et al., 2011; Azene and Molla, 2017).

CONCLUSION

Taro corms (*Colocasia Esculenta*), also called *pindalu* in Nepalese society were analyzed and found to be a good source of carbohydrates, rich in minerals including potassium, calcium, phosphorous, and sodium. Many plant-based foods contain anti-nutrients that serve as a defense mechanism against herbivores and pathogens. Anti-nutrients can be detrimental to human health as they hinder the digestion and absorption of vitamins, minerals, and other nutrients, leading to long-term deficiencies. Raw taro corm contains some antinutritional factors such as oxalate, phytate and tannin which can limit the utilization of taro nutrients for human consumption and animal feed. Boiling, chemical treatments and frying process of raw taro corms significantly reduced all the antinutritional that were analyzed in this study.

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