The Study on Phytochemical Constituents, Nutritional Value and Antimicrobial Activities of *Solanum betaceum* Cav. from Falam Township in Chin State

Khin Myo Win*, San San Oo, Khin Pale*****

Abstract

The fruits of *Solanum betaceum* Cav. belonging to family Solanaceae, have been used to treat some diseases in Chin State. The nutritional values of fruit pulp were evaluated for its value such as protein, fiber, fat and carbohydrate according to the method of AOAC. The phytochemical studied that the fruit contains alkaloids, saponin, flavonoids, carbohydrates, tannins and phenolic compound etc. The contents of elements were analyzed by using Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometer. Potassium, calcium, phosphorus and others elements can be found in the fruit of *Solanum betaceum* Cav. Then, antimicrobial activities of the fruit *Solanum betaceum* Cav. were studied on microorganisms. In antimicrobial activities, the methanol extract showed inhibition zone on *Escherichia coli* (15 mm) and *Candida albicans* (12mm). The ethanol extract showed inhibition zone on *Pseudomonas aeruginosa* (11mm), *Escherichia coli* (13mm) and *Candida albicans* (13mm). It is suggested that the fruit of *Solanum betaceum* Cav. should be eaten because it contains nutritional value and antimicrobial activity for human health.

Keywords: *Solanum betaceum* Cav., antimicrobial activity.

Introduction

Plants provide people with medicines, shelter, furniture, beautiful ornamentations, and fibers for paper, clothing and foods. Plants have been used for centuries to treat infectious diseases and are considered as an important source of new antimicrobial agents (Bereksi *et al.*, 2018).

In Myanmar, most people have been living in rural areas and have used traditional medicine for healthcare needs for the past decades. Myanmar traditional medicine afforded healthiness and longevity to ancient Myanmar people (Chandarana *et al.*, 2005). The leaves and fruits of *Solanum betaceum* Cav. are used for the treatment of sore throat, inflamed tonsils and gums in folk medicine (Bohs, 1989).

The mature fruit juice of *Solanum betaceum* Cav. is traditionally used in Ecuador to cure of tonsillitis, high cholesterol and stomach diseases. (Mandal and Ghosal, 2012)

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Many of the fruits and vegetables are having very rich in bioactive components. These are considered to have beneficial effects on health. The various fruits contain abundant dietary fiber, vitamins and minerals for health benefits (Li *et al*., 2016). The fruit of *Solanum betaceum* Cav. is a rich of vitamins A, C, provitamin A and an excellence source of calcium, iron, potassium, phosphorus, magnesium and other elements (Nallakurumban, 2015). The extracts of *Solanum betaceum* Cav. fruit have antimicrobial activities (Thanh Diep *et al.,* (2021).

The plant of *Solanum betaceum* Cav. belongs to the family Solanaceae and is known as Tamarillo in English name. *Solanum betaceum* Cav. has been chosen in this research because it is one of the most famous fruits in Chin State. *Solanum betaceum* Cav. is also known as Turbung in Chin. Myanmar name is taung-paw-hkayan chin. It grows at a high altitude of Falam Township and its surrounding areas. The ripe fruits of *Solanum betaceum* Cav. are baked for few minutes. Afterwards it is mixed with chilli powder, salts, ginger, onion and garlic for salad. Moreover it is eaten as peeled off and is mixed with kazun-ywet, gourd, pin-sein as soup. The aim of the study is to know the contents of nutritional value, chemical constituents, elements and antimicrobial activities in its fruit for human health.

Materials and Methods

(i) Plant collection and identification of plant specimens

The fruits of *Solanum betaceum* Cav. were collected from Falam Township, Chin State, during the flowering and fruiting period on November 2015. Falam Township is situated at latitude 22°91' North and longitude 93° 67' East (Figure 1). The elevation of above sea level is 5351 feet. The specimen was studied for taxonomical description and identified with the help of literature such as Flora of Java (Backer & Brink, 1965) and Dassanayake (1975). Habit, Inflorescence, flower and fruit of the plant were recorded by using digital camera.

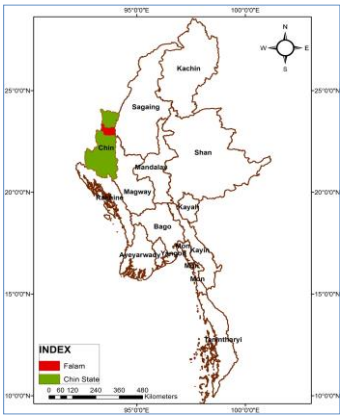

Figure 1. Map of Falam Township in Chin State of Myanmar.

(ii) Preparation of powdered samples

The fruits of *Solanum betaceum* Cav. were washed and sliced into small pieces. Then, these samples were placed in an oven for 48 hours at low temperature 60°C. After being completely dried, the dried samples were grounded into the powder by using blender. The powder was stored in a container and also used for the further experiment.

(iii) Preliminary study on Phytochemical screening of *Solanum betaceum* Cav. fruit.

The fruits of *Solanum betaceum* Cav. were tested for phytochemical constituents by various chemical tests. The presence or absence of alkaloids, saponins, tannins, reducing sugars, glycosides, starch, carbohydrates, phenolic compounds and flavonoids were studied according to the methods of Harbone (1984).

(iv) Nutritional values of *Solanum betaceum* Cav. Fruits

The fruits of *S. betaceum* Cav. were evaluated for its nutritional values such as moisture, protein, fibre, fat and carbohydrate and energy at Food Industries Development Supporting Laboratory (FIDSL), Myanmar Food Processors and Exporters Association (MFPEA), Yangon, Myanmar. The procedures of nutritional value were studied according to the method of AOAC (Horwitz, 1980).

Determination of protein content

Protein content of the foodstuff is obtained by estimating the nitrogen content of the material. The amount of nitrogen present in the protein, when digested with conc: sulphuric acid in the presence of catalyst (potassium sulphate and copper sulphate) is converted into ammonium sulphate from which ammonia is liberated when it is treated with strong alkali.

(v) Elemental analysis of powdered fruits of *Solanum betaceum* Cav.

Elemental analysis was performed by Energy Dispersive X-ray Fluorescence (EDXRF) at Universities' Research Centre, University of Mandalay.

(vi) Screening of Antimicrobial Activity of *Solanum betaceum* Cav.

Different solvent extracts of fruits of *Solanum betaceum* Cav. were used to perform the antimicrobial activities by agar-well diffusion method. In this method, nutrient agar was used as culture media. For initial screening, nutrient agar was prepared according to the method described by Cruickshank (1975). Four grams of nutrient agar were boiled with 150 ml of distilled water and 20-25ml of the medium was poured into each test tube and plugged with cotton wool and sterilized at 121°C for 15 minutes in autoclave. Then the tubes were cooled down at 30-35°C and poured into sterilized Petri dishes and 0.1 – 0.2 ml of test organism was also added into the dishes. The agar was allowed to set for 2-3 hours. Then, 10 mm plate agar well was made with the help of sterilized agar well cutter.

After that, about 1.2 ml of sample was introduced into the agar well and incubated at 37°C for 24 hours. The inhibition zone appeared around the agar well, indicating that the

presence of antimicrobial activity. At the same time, the control experiments using solvent only were prepared for the comparison with samples. The antimicrobial activity of different solvent extracts of fruits was measured from the diameter zone of inhibition. The solvent extracts of fruits were tested against six pathogenic tested microorganisms by agar-well diffusion method by Cruickshank (1975), the tests were conducted at the central Research Development Center (CRDC), Yangon, Myanmar. Test microorganisms, code numbers and diseases were shown in Table 1.

Table 1. Test microorganisms, Code number and Diseases.

No.	Test microorganisms	Code No.	Diseases
1.	*Bacillus pumilus*	IFO-12102	Infection and soft tissue infection
2.	*Bacillus subtilis*	JAP-0221215	Food spoilage and fever
3.	*Escherichia coli*	ATCC-25922	Diarrhea, dysentery, urinary infection.
4.	*Pseudomonas aeruginosa*	IFO-3080	Chronic and inflammation in bones
5.	*Staphylococcus aureus*	ATCC-12277	Food poisoning, burns, vomiting, illness
6.	*Candida albicans*	IFO-1060	Skin infection, intestinal tract infection

Results

(i)Morphological characters of *Solanum betaceum* Cav.

Family - Solanaceae

English Name - Tree Tomato (or) Tamarillo

Myanmar Name - Taung paw hkayan chin

Chin Name - Turbung

Flower and fruiting Period - June to November

Perennial, erect, small tree. Leaves, simple, alternate, exstipulate, petiolate, petiole 10 to 15 cm long, very large. Leafblades ovate, entire, acute at the apex, cordate at the base. Inflorescences extra axillary, dichasial cyme, pendulous. Flowers white to pink, ebracteate, pedicellate, pubescent, bisexual, actinomorphic, pentamerous, hypogynous. Calyx campanulate, 5-lobed, persistent, fused, pubescent. Corolla stellate- shaped, 5 – lobed, fused, white to pink, campanulate at young and then reflexed at the apex, fleshy, scented. Stamens 5, yellow, inserted at the throat of corolla tube; filaments short; anthers dithecous, basifixed, dehiscence by apical pores. Ovary superior, bicarpellary, syncarpous, bilocular with numerous ovules on the axile placentae, style thick, exerted between the anthers, stigma flat. Fruits berry, ovoid, mostly acute the apex, glabrous, brick red, longitudinal strips. Seeds disc-shaped, pale brown.

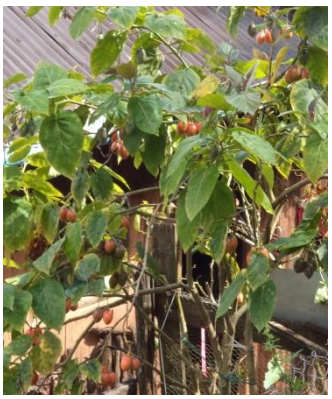

Figure 2. Habit

Figure 3. Inflorescences

Figure 4. fruit

Figure 5. T.S ovary

(ii) Preliminary study on Phytochemical screening of *Solanum betaceum* Cav. fruit.

The phytochemical screening of the fruit of *Solanum betaceum* Cav. contains alkaloids, carbohydrates, flavonoids, glycosides, phenolic compounds, reducing sugars, starch, saponin and tannins. The result showed in table 2.

Table 2. Results of phytochemical studies on *Solanum betaceum* Cav.

No.	Constituents	Extracts	Test Reagents	Observation	Results
1.	Alkaloids	1% HCL	Dragendorff's reagent Mayer's reagent Wagner's reagent	Orange ppt Cream ppt Brown ppt	+
2.	Carbohydrates	D.W	10% α-naphthol, conc: H_2SO_4	Purple ring	+
3.	Flavonoids	95%ethanol	Conc. HCl, Mg	Pale pink color	+
4.	Glycosides	D.W	10% lead acetate	White ppt	+
5.	Phenolic compounds	Ethanol	3% $FeCl_3$ solution	Green ppt	+
6.	Reducing sugars	D.W	Fehling's solution A and B	Orange ppt	+
7.	Starch	Ethanol	Iodine solution	Black color ppt	+
8.	Saponin	D.W	Shaken with distilled water	froth	+
9.	Tannins	Ethanol	10% ferric chloride solution	Green color	+

(+) present, (D.W) - Distilled water (ppt) - precipitate

(iii) Determination of Nutritional values of *Solanum betaceum* Cav.

According to the experiments, the edible portion constituted 99.6% of the fruit contains moisture (81.51%), ash (0.91%), protein 2.06%, crude fiber 3.46%. Carbohydrate also contains 11.98% in fruit pulp and energy value has 57 Kcal in its. The content of fat has low in fruit. The result of nutritional values of the *Solanum betaceum* Cav. fruits was shown in Table 3.

Table 3. Nutritional values of *Solanum betaceum* Cav. Fruits.

No.	Test Parameter	Results	No.	Test Parameter	Results
1.	Moisture	81.51%	5.	Ether extract Crude Fat	0.08%
2.	Ash	0.91%	6.	Carbohydrate	11.98%
3.	Protein	2.06%	7.	Energy value(Kcal/100g)	57 Kcal
4.	Crude Fiber	3.46%			

(iv) Elemental analysis of powdered fruits of *Solanum betaceum* Cav.

The contents of element in the fruits of *Solanum betaceum* Cav. were determined by EDXRF, the fruit contains potassium (K), calcium (Ca), phosphorus (P), manganese (Mn), Iron (Fe) and other elements. The data were shown in Table 4.

Table 4. Elemental analysis of powdered fruits of *Solanum betaceum* Cav.

Z	Symbol	Element	Netto Counts	Concentration	Abs.Error
19	K	Potassium	1340463	3.536 %	0.004 %
17	Cl	Chlorine	2181546	0.4660 %	0.0007 %
20	Ca	Calcium	93372	0.1810 %	0.0012 %
15	P	Phosphorus	478538	0.1653 %	0.0006 %
13	Al	Aluminium	29834	0.0621%	0.0024%
16	S	Sulfur	439462	0.03452 %	0.00010 %
26	Fe	Iron	15683	0.00568%	0.00006%
25	Mn	Manganese	1694	0.00170%	0.00008%
30	Zn	Zinc	4905	0.00071%	0.00002%

(v) Antimicrobial activities of various solvent extracts of fruit of *Solanum betaceum* Cav.

The antimicrobial activities of fruit extracts were carried out by various solvents such as petroleum-ether, methanol, ethyl acetate, ethanol and aqueous solutions. The results of antimicrobial activity of the fruit extracts against on microorganisms as shown in table 5 and figure 6. The methanol extract of *Solanum betaceum* Cav. fruit has shown inhibition zone against on *Candida albicans* (12mm), *Escherichia coli* (15mm), and *Pseudomonas aeruginosa* (11mm). The zone of inhibition on *Candida albicans* (13mm) and *Escherichia coli* (13mm) has been found in ethanol extract of its fruit. The water and ethyl acetate extract of fruit showed that antimicrobial activities against on *Escherichia coli* (11mm) and *Candida albicans* (12mm). The solvent of the petroleum ether has not found antimicrobial activities on organisms.

Table 5. Antimicrobial activities on various solvent extracts of *Solanum betaceum* Cav. fruits.

Organisms	Diameter zone of inhibition (mm)				
	Pet - ether	Methanol	Ethyl Acetate	Ethanol	Water
Bacillus subtilis	-				-
Bacillus pumilus	-	-	-	-	-
Escherichia coli	-	15mm (++)	-	13mm(+)	11mm(+)
Staphylococcus aureus	-	-	-	-	-
Pseudomonas aerugonosa	-	11mm (+)	-	-	-
Candida albicans	-	12mm(+)	12mm(+)	13mm(+)	-
Agar well- 10mm, 10mm~14mm (+), 15mm~19mm(++), 20mm above (+++)					

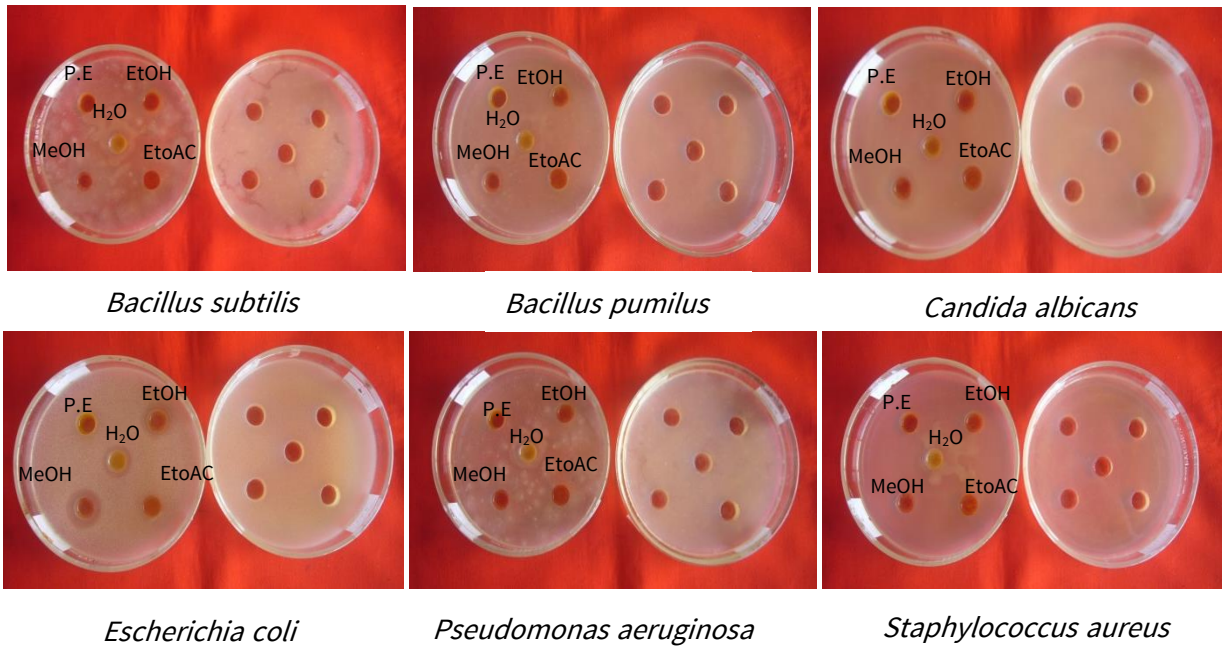

Figure 6. Antimicrobial activities of *Solanum betaceum* Cav. fruit on six microorganisms.

Discussion and Conclusion

The plant *Solanum betaceum* Cav. belongs to the family Solanaceae. The local name of this plant is Taung paw hkayan chin and turbung in Chin. The fruit of *Solanum betaceum* Cav. is eaten raw and also cooked as curry. It is bitter- sweet when ripe on maturity.

In the present study, the morphological characters of *Solanum betaceum* Cav. had been studied. The plant is perennial small tree. The leaves are simple, alternate, very large and blades ovate. Inflorescences are extra axillary, dichasial cyme. Corolla stellate -shaped, fleshy, white to pink. Stamens 5, fused, yellow, anthers dithecous, basifixed, dehiscence by apical pores. Fruits are berries, ovoid, brick-red in colour and smooth. These findings agreed with the Backer (1965).

The phytochemical constituents of the *Solanum betaceum* Cav. showed that the presence of alkaloids, phenolic compound, carbohydrates, flavonoids, reducing sugar, saponin, starch tannin and glycoside have been studied. These finding are in line with Viera *et al.* (2010) who described that flavonoids have activities of antioxidant, antibacterial, antiviral, antiallergic, anticancer and anti-inflammatory. Saptarini (2018) reported that the fruit of *Solanum betaceum* Cav. contains vitamin (A, B_6, C, and E), flavonoids, terpenoids, steroids, carotenoids, saponins, alkaloids, tannins, and fiber. Fruits containing rich in flavonoids and various chemical compounds may help to protect cell and slow the growth rate of lung and oral cavity cancers. Therefore, the fruit of *Solanum betaceum* Cav. is able to prevent diseases because its fruit contains various chemical constituents.

The constituents of nutritional values of *Solanum betaceum* Cav. fruit were evaluated that the moisture is 81.51% and the carbohydrate contains 11.98% in its fruit. The fruit of *Solanum betaceum* Cav. has fiber (3.46%), 2.06% protein, 0.08% fat and 57 Kcal energy. According to the results, the fruit contains low amount of calorie. Ken (2007) stated that carbohydrates enhance human health by delivering vitamins and minerals. This finding was agreed with that of Ken (2007), Rana and Brar (2019). Thus, people should be consumed to *Solanum betaceum* Cav. fruit for health as supplement food due to it fruits containing the nutritional values.

The analysis of mineral content of *Solanum betaceum* Cav. fruit contained potassium, calcium, phosphorus, manganese, zinc, iron and other elements. Potassium helps to balance high sodium levels in the heart of human body. Pravina *et al* (2013) stated that calcium is essential in muscle constriction, building strong bones and teeth, blood clotting, nerve impulse, regulating heart beat and fluid balance within cells. So, *Solanum betaceum* Cav. fruit is good to cure for various diseases.

The antimicrobial activities of *Solanum betaceum* Cav. fruit were tested on six different types of microorganisms. The methanol extract showed that the zone of inhibition on *Escherichia coli* (15 mm), *Candida albicans* (12 mm) and *Pseudomonas aeruginosa* (11 mm) and are not found on *Bacillus subtilis, Staphylococcus aureus* and *Bacillus pumilus*. The ethanol extract was shown the zones of 13 mm against *E. coli* and *Candida albicans*. The ethyl acetate and water showed the inhibition zone of antimicrobial activities on *E. coli* (12mm) and *Candida albicans* (11 mm). The petroleum ether was not observed inhibition zone on microorganisms. This study, indicated that the methanol extract showed the significant antimicrobial activity against on *E. coli* and *Candida albicans.* The results of antimicrobial activities agreed with Thanh Diep *et al*., (2021). Thanh Diep *et al.,* (2021) described that methanol, ethanol, and water extracts showed inhibiting antimicrobial activities. Thus, the fruit of *Solanum betaceum* Cav. is able to against antimicrobial activities.

It can be concluded that the fruit of *Solanum betaceum* Cav. effects for human health. This fruit contains carbohydrate, protein and energy and has antimicrobial activities against on *Escherichia coli* and *Candida albicans.* Therefore, the fruit of *Solanum betaceum* Cav. can be used to treat for some diseases. It was suggested that the fruit of *Solanum betaceum* Cav. should be eaten because it contains chemical compounds, nutritional value and antimicrobial activities for human health.

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