Nutritional Assessment of Indonesian Chilli Landraces
(*Capsicum chinense* Jaqc.)

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Abstract. Chillies (*Capsicum spp.*) are highly nutritious vegetables and spices and are an important component in the Asian cuisine due to their aroma attributes and health value. To gain a better insight of the health value of chillies in North Toraja, South Sulawesi, Indonesia, the nutrient content, the morphological parameters and the yield of three different chilli landraces of the variety ‘Katokkon’ (*Capsicum chinense* Jaqc.), i.e. ‘Limbong Sampolo’, ‘Leatung 1’, and ‘Leatung 2’ were investigated. The nutrient parameters included capsaicin, pro-vitamin A, and vitamin C contents. Moreover, those differences were studied in two villages (Buntu Datu and To’pao) for the landrace ‘Leatung 2’. The research was performed with dried chillies using high pressure thin layer chromatography for the determination of capsaicin content, spectrophotometric determination for pro-vitamin A and iodometry for vitamin C content. The results showed that the capsaicin content varied between 7.91 mg/g DM (‘Leatung 1’) to 9.94 mg/g DM (‘Limbong Sampolo’) which corresponds with values on the Scoville heat unit (SHU) ranging from 118,712.677 to 149,074.747. The pro-vitamin A content was found to be highest (1.01 mg/g DM) in ‘Limbong Sampolo’ and lowest (0.60 mg/g DM) in ‘Leatung 2’ from To’pao. Vitamin C was found to be lowest (0.20 mg/g DM) in ‘Leatung 2’ from Buntu Datu and highest (0.26 mg/g DM) in ‘Leatung 1’. The statistical analysis showed that there were no significant differences between the landraces and the villages for ‘Leatung 2’. Compared to the capsaicin values in literature (up to SHU 600,000), the landraces showed lower values. This was also found for the pro-vitamin A contents. In contrast, the vitamin C values were higher than those reported in literature. In conclusion, it can be stated, that the three landraces of ‘Katokkon’ in general showed high nutritious values, irrespectively of the different growing conditions in the two villages.

1 Introduction

Based on its taste and various health value compounds, chilli (*Capsicum spp.*) is an important component of many Asian cuisines and is greatly demanded by consumers all over the world [1]. In Indonesia, chilli cultivation is increasing due to an improved infrastructure in agricultural technologies and communication systems [2]. The rural agribusiness is more profitable when shifting from intensive rice to a more intense chilli production. This enables an increase in the rural economy due to a more labour and material-intense production, which in turn leads to a higher income of farmers specifically for chilli production which is one of the most vital commercial vegetable [3]. The economic importance of chilli is based on the multiple use of the spicy fruits, as raw or processed material for food production or for pharmaceutical industry purposes [4]. However, apart from local differences, chilli is mainly consumed fresh or in crushed form, known as “sambal” [5].
Ripe *Capsicum* fruits comprise of approx. 1% protein, 0.3% fat, 4-6% carbohydrates and are a rich source of vitamins, especially vitamin C and pro-vitamin A [6]. One of the main constituents in chilli is capsaicin [7]. However, the nutrient composition and contents in chilli might differ greatly depending on the cultivar, harvest time, storage conditions, and preparation techniques [8].

Therefore, to gain a better insight of the nutrition and health value of chillies in North Toraja, South Sulawesi, Indonesia, the nutrient content, morphological parameters and yield of three different chilli landraces of the variety ‘Katokkon’ (*Capsicum chinense* Jacq.), i.e. ‘Limbong Sampolo’, ‘Leatung 1’, and ‘Leatung 2’, were investigated in two villages (To’pao and Buntu Datu). Both villages are part of the research farmer programme implemented by the community development program Motivator Kondoran of the Church of Toraja. In this program, farmers conduct on-farm trials supported by Motivator Kondoran and the Universitas Hasanuddin (UNHAS) to sustainably intensify their production systems in rice and chilli.

2 Material and Methods

2.1 ‘Katokkon’ landraces

Landraces of the ‘Katokkon’ chilli (*Capsicum chinense* Jacq. ssp.) were selected based on their various fruit appearances. ‘Limbong Sampolo’, ‘Leatung 1’ and ‘Leatung 2’ are named after the villages from which seeds were obtained. In these villages, ‘Katokkon’ chillies are mainly cultivated, however, the names of the landraces have not been officially registered yet.

The different types of ‘Katokkon’ have similarities regarding their morphological and vegetative characteristics. Leaves have an elliptic shape, round leaf bases and a pinnate frame. In a juvenile stage, the fruits of ‘Limbong Sampolo’, which are round, curved in shape and less pointed, show purple colour around the calyx. With increasing ripening, the colour disappears with maturity. Fruits of ‘Leatung 1’ and ‘Leatung 2’ are generally more elongated in shape and more pointed. The characteristics of the described landraces are shown in Table 1.

Table 1: Characteristics of the ‘Katokkon’ landraces (*Capsicum chinense* Jacq.) cultivated in Tana Toraja, South Sulawesi, Indonesia

| Parameters         | ‘Limbong Sampolo’ | ‘Leatung 1’ | ‘Leatung 2’ |
|--------------------|-------------------|-------------|-------------|
| Seed origin        | Limbong Sampolo   | Leatung     | Leatung     |
| Leaf shape         | Elliptic          |             |             |
| Leaf tip           | Tapered           |             |             |
| Leaf base          | Rounded           |             |             |
| Leaf frame         | Pinnate           |             |             |
| Leaf colour        | Dark green        |             |             |
| Unripe fruit colour| Green with a purple calyx | Dark green |             |
| Ripe fruit colour  | Bright red        |             |             |
| Fruit shape        | Round, curved     | Oval        | Round at upper part, tapered at base |
2.2. Experimental site and experimental design

An on-site research was established in To’pao (altitude: 928 m) and Buntu Datu (altitude: 860 m), Tana Toraja, South Sulawesi, Indonesia. Both villages are representative for small rural structures with rice-based smallholder farming systems. Farmers are active participants of the climate field schools and conduct as so-called research farmers on-farm trials on chilli and rice for the past four years.

Annual rainfalls in 2019 were about 2,158 mm in To’pao and 1,915 mm in Buntu Datu. To’pao had an average monthly maximum and minimum temperature of 32 °C and 17 °C, respectively from January to December 2019. Due to inchoate weather recording in Buntu Datu, the weather records were only available for the period from January to May 2019. The average monthly maximum and minimum temperature were about 21 °C and 19 °C, respectively.

The on-farm trials have been set up as randomized two-factorial plot design. The whole-plot factor consisted of three ‘Katokkon’ landraces (Capsicum chinense Jacq.). Each experimental site had 27 trial plots with dimensions of 1x5 m for three different fertiliser treatments and three different seed types. For this study, only chillies with a 50% Tithonia (Tithonia) fertiliser treatment were harvested. The fertiliser consisted of buffalo manure, straw, leaves of the Gamal shrub (Gliricidia sepium) and banana stems. Originally, each trial plot was planted with 15 chilli shrubs. The distance between the individual shrubs in the row amounted to 30 cm. The distance of the shrubs being opposite were 50 cm. At least one yellow trap was set per experimental plot to catch pests. Table 2 describes the cultivation procedures of chilli that has been harvested for the present study.

### Table 2: Steps in chilli cultivation of ‘Katokkon’ landraces (Capsicum chinense Jacq.)

| Season | Land Preparation | Planting/fertiliser application | Weed/pest management | Harvesting |
|--------|------------------|---------------------------------|----------------------|------------|
| 2019   | Land clearance, soil tillaging and planting bed formation | 16/01/19 – planting in To’pao 18/01/19 – planting in Buntu Datu | Weeding by hand, application of biopesticides, yellow traps, barrier plants (maize), mulching with silver foil | 04/2019 first harvest in both villages 30/08/2019 last harvest in To’pao 06/09/2019 last harvest in Buntu Datu |
|        |                  |                                 |                      |            |

The research took place from August until mid of October in 2019. All treatments, e.g. application of compost, biopesticides and organic liquid fertiliser, were conducted by the farmers, which were bound to the required organic practices of the climate field school programme. The plot design was supported by researchers from UNHAS.

2.3 Compound analysis and data analysis

The different landraces of chillies collected from the two villages were separately dried in an incubator (incubator I, size 55; Company “Memmert”) at 67 °C, instead of 70 °C due to fluctuation in temperature. The individual samples with a minimum weight of 5 g dry matter were subjected for analysis of vitamin C using iodometry [9], for pro-vitamin A using spectrophotometry [10] and capsaicin using high-performance thin layer chromatography [11]. Statistic data analysis between the landraces and the villages were conducted with ANOVA [12].
3 Results and Discussion

3.1 Plant growth and yield of different chilli landraces

The morphological characteristics studied included the plant height of the chilli bushes. The yield per landrace and village was also recorded.

The measurement of the chilli bushes showed that there were differences between the individual landraces in plant height. ‘Leatung 2’ in Buntu Datu showed a higher average plant height of 63.23 cm in comparison to the landraces from To'pao (Figure 1). All landraces cultivated in To'pao, i.e. ‘Limbong Sampolo’, ‘Leatung1’ and ‘Leatung 2’ were similar in plant height and only showed slight differences that differed not significantly from each other (Figure 1). The average shrub height of the ‘Katokkon’ landraces in To’pao was 45.23 cm.

The crop yields differed between the individual landraces and between the two villages regarding ‘Leatung 2’, however also here without statistical significance (Figure 2).

![Figure 1: Average plant height [cm] of 'Katokkon' landraces (Capsicum chinense Jaqc.) cultivated in To’pao and Buntu Datu in 2019](image)

Compared to values in literature, the three landraces were relatively small as chili bushes can grow up to 1.5 m [12]. Therefore, the landraces were more than half smaller than those of other Capsicum chinense types.
Figure 2: Average yield [g/plant] of ‘Katokkon’ landraces (*Capsicum chinense* Jacq.) in To’pao and Buntu Datu from August to October 2019.

Results indicated that ‘Limbong Sampolo’ proved to be the most productive landrace in To’pao in the harvest period from August to September 2019. ‘Leatung 2’ was also relatively productive. In contrast, in Buntu Datu, ‘Leatung 2’ was found to be a lower productive landrace of ‘Katokkon’. Yields at higher altitudes can reach above 1,000 g/shrub [13]. Thus, the present results (Figure 2) reveal that yields in Buntu Datu of the two months harvest did not correspond to the higher values reported in literature.

3.2. Nutritional value of different chilli landraces

The average nutritional value components differed between the Katokkon landraces and two villages, however only tendentiously. ‘Limbong Sampolo’ was the landrace with the highest capsaicin and pro-vitamin A contents. ‘Leatung 1’, on the other hand, had the highest vitamin C content (Table 3). The variance analysis, however, showed that there were no significant differences.

Table 3: Average nutrient contents of ‘Katokkon’ landraces (*Capsicum chinense* Jacq.) in the two villages. Values are means ± SD.

| Village | Landrace     | Capsaicin [ppm] | Pro-Vitamin A [mg/g] | Vitamin C [mg/g] |
|---------|--------------|-----------------|----------------------|------------------|
| To’pao  | ‘Limbong Sampolo’ | 9,938 ± 1,312   | 1.01 ± 0.24          | 0.24 ± 0.04      |
|         | ‘Leatung 1’   | 7,914 ± 2,172   | 0.70 ± 0.30          | 0.26 ± 0.07      |
The contents of nutrients found in the present study for ‘Katokkon’ landraces were partly in agreement with those found in literature. The capsaicin values correspond with values on the Scoville heat unit (SHU) above 80,000 and therefore can be considered as very highly pungent chilli. In fact, the SHU levels range between 118,712.677 for ‘Leatung 1’ to 149,074.747 for ‘Limbong Sampolo’. The analysed amounts of capsaicin were tendentiously in agreement with those found in ‘Chiengpi’ or ‘Umrok’ (*Capsicum chinense* Jacq.) with 7,900-20,600 ppm [14]. The pro-vitamin A contents in the observed landraces were lower than in other *Capsicum chinense* cultivars, e.g. cv Aji Brown was found to have a pro-vitamin A content of 0.28 mg/g DM [15]. Fresh chillies of ‘Katokkon’ are reported to comprise of a vitamin C content of about 0.16 mg/g fresh mass [16]. In contrast, this experiment of dried chillies showed higher vitamin C values of all three landraces.

4. **Conclusion**

From the present results, it can be concluded that there were no significant differences between the Katokkon landraces ‘Limbong Sampolo’, ‘Leatung 1’ and ‘Leatung 2’ under the different growing conditions in the two villages. However, among the landraces studied, tendentiously ‘Limbong Sampolo’ was found to be the most productive landrace with the highest yield in To’pao in the harvest period from August to September 2019. In terms of morphological characteristics, ‘Leatung 2’ was found to have the highest plant height compared with the other landraces in both villages. The different landraces ‘Limbong Sampolo’, ‘Leatung 1’ and ‘Leatung 2’ proved a high nutritional value in both villages. The types from Leatung (cultivated in To’pao) showed strong similarities in their nutrient content. Furthermore, in general, the nutrient contents in the ‘Katokkon’ landraces studied were consistent with those reported in literature. Tendentiously, contents of vitamin C found in ‘Limbong Sampolo’, ‘Leatung 1’ and ‘Leatung 2’ were slightly higher than those found in literature, whereas pro-vitamin A was slightly lower in the present landraces. All three landraces can be classified as very highly pungent chilli types and are comparable to the hot Habanero peppers or Scotch Bonnet chillies.

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