Tropentag 2013, Stuttgart, Germany
September 17-19, 2013

Conference on International Research on Food Security, Natural Resource Management and Rural Development
organised by the University of Hohenheim

Analysis of Assam Tea Processing in Small Scale Factories in the Highlands of Northern Thailand

Jakob Johannson[a], Theerapong Theppakorn[b], Vicha Sardsud[c], Wolfram Spreer[a], Daruni Naphrom[d], Joachim Müller[a]

[a] Universität Hohenheim, Inst. of Agricultural Engineering, Tropics and Subtropics Group, Stuttgart, Germany
[b] Mae Fah Luang University, School of Agro-Industry, Chiang Rai, Thailand
[c] Chiang Mai University, Postharvest Technology Research Institute, Chiang Mai, Thailand
[d] Chiang Mai University, Department of Horticulture, Chiang Mai, Thailand

Introduction

In the recent decades unsustainable land use practices have led to land degradation in highland areas all over the world. In the future, more sustainable land use strategies need to maintain natural resource availability in marginal land sites. At the same time, highland cropping systems need to ensure the livelihood of the local population.

Tea originates from Asia and physiologically fits into the climatic conditions of Northern Thailand. As a perennial crop it offers permanent soil coverage and thereby contributes to a more sustainable land use form. The youngest leaves of the tea plant are harvested and processed in order to produce black, green, Oolong, white and red tea. Tea processing is a measure to change the leaves physically and chemically in order to give tea leaves a unique taste and shape. Furthermore, the reduction of moisture content in the tea leaves makes the products storable and reduces transportation costs. From the tea producers' point of view, processing tea leaves means adding value to the product and creating income. Presently, processing is mainly done in the lowland by factories. On-site processing in highland tea growing communities would create cash flow in rural communities.

In this study, three local small-scale tea processing units in Chiang Rai Province have been analysed in terms of green and black Assam Tea processing practices and derived product quality. The chosen representative local processing units were observed during daily business operation and tea samples were collected and analysed in the laboratories of Mae Fah Luang University's Tea Institute. The aim of this study project was to describe local small-scale tea producing structures in Northern Thailand and to compare the present production standards to international market requirements.

Material and Methods

Location of study – The involved tea processing units of this study are located in Baan Wawee (Wawee Sub-district, Mae Suai District, Chiang Rai Province and its close surroundings. Baan Wawee is located at an altitude of about 850 m.s.l. on Doi Wawee Mountain (19°55'50" N, 99°29'30" E). Chiang Rai Province is located in the tropical climate zone with an annual average temperature of 24.9 °C and total annual rainfall of 1705 mm.

Observation of tea processing in Wawee and sample collection – The chosen tea processing units were surveyed during daily business routines. Tea processing procedures of black and green tea were observed. Observations were documented through measurements of temperature via infrared thermometer (Voltcraft IR 260-8S) and time elapsed for certain tea processing steps. Photographs were made to illustrate present infrastructure and working procedures. Three batches of tea samples (after every single processing step of green and black tea production) were collected at the chosen tea processing units between November 2012 and January 2013.

Laboratory analysis – Leaf samples were oven dried at 103 °C for 20 hours to determine moisture content (MC). Total polyphenol content (TPC) was analysed via spectrophotometer (type: Analytik Jena, SPEKOL 1500). Total catechin content (TCC), individual catechin configuration (ICC) and caffeine content (CF) were analysed via high-performance liquid chromatography (HPLC) following ISO 14502-2 (2005).

Key informant interviews – Two different groups were interviewed during this study: the three involved processing unit owners and a group of 28 local tea farmers who provided fresh tea leaves to the involved processing units. The processing unit owners were interviewed to support results and observations, and to get further information on processing and the involved facilities. Obtaining information on the raw material was ensured by the farmer interviews.

Statistical analysis – All data derived from lab analysis was recorded via Microsoft Excel and analysed statistically. Quantitative data for MC, TPC, TCC/ICC and CF were analysed by descriptive statistics and compared by ANOVA to show differences between batches and processing units.

Results and Discussion

It was found that green and black tea were produced in the same sequence of processing steps, but with variability in fresh tea leaf quality, elapsed time and processing temperature. In Wawee tea processing, in contrast to generally common practices, the first three steps of green and black tea (withering, roasting, rolling) were identical. Only after these steps were finished, black tea was oxidized and then final-dried while green tea was dried immediately. In common tea processing practice, black tea leaves are not roasted as the roasting process deactivates tea leaf inherent enzymes and thereby inhibits oxidation.

The moisture content was considered as an indicator on how accurate the processing steps were implemented. For a constant tea processing chain with standardized conditions, mean moisture content levels with low variance are necessary. The results implied that throughout the processing chain the standard deviation (SD) increased in relation to the mean value – expressed through an increasing coefficient of variation (CV) (Table 1). Especially, the oxidation and final drying steps showed high SD and CV. Ideally, the final MC should be between 3 and 5 % (Graham, 1992). The high SD implied that in the several collected sample batches higher and lower values were reached. A maximum MC of 7 % should not be exceeded as fungal colonization could possibly occur, leading to contamination with mycotoxins. Significant differences of MC have been detected in the observed processing units (PU 1, PU 2 and PU 3).

Table 1. Mean moisture content (MC, in g/100 g), standard deviation (SD) and coefficient of variation (CV) of black tea samples throughout processing at three processing units (PU 1, 2 and 3) in Wawee

		Withering	**Roasting**	**Rolling**	**Oxidation**	**Dried Tea**
	Mean MC	72.85 b	69.84 b	69.48 b	35.39 a	7.94 a
PU 1	SD	4.42	5.17	4.82	30.77	2.09
	CV	0.06	0.07	0.07	0.87	0.26
	Mean MC	75.84 a	75.10 a	75.07 a	21.66 a	2.76 b
PU 2	SD	2.81	3.99	2.91	11.37	1.13
	CV	0.04	0.05	0.04	0.52	0.41
	Mean MC	75.64 a	70.11 b	67.53 b	28.63 a	4.24 b
PU 3	SD	1.23	2.96	1.86	6.20	4.26
	CV	0.02	0.04	0.03	0.22	1.00

Withering, roasting, rolling: n = 18; oxidation and dried tea: n = 9. Values of the same column followed by the same letter are not statistically different (p = 0.05).

It was found that TCC, TPC and CF content were lower than expected. Catechin content levels of 20 - 30% have been reported by MUTHUMANI & SENTHIL KUMAR (2007) and RUSAK *et al.* (2008). Catechins can be reduced during processing forming theaflavins and thearubigins, especially during black tea oxidation processes catalysed by the tea-inherent enzymes polyphenol oxidase and peroxidase (Muthumani & Senthil Kumar, 2007). During this study, a maximum of 8g per 100g DM has not been exceeded (Table 2). The polyphenol content was expected to be around 30 % (Theppakorn & Wongsakul 2012). In Wawee tea processing units the mean values only reached up to 16.5g per 100g DM (Gallic Acid Equivalent). GRAHAM (1992) reported that caffeine content in tea is usually 2.5 to 4.5% while in the caffeine analyses of Wawee tea a maximum mean value of 2.10g per 100g DM has been detected. All three analysed chemical compounds showed a change from roasting to rolling. The rolling process, which physically squeezes and crushes the leaves in order to break the cell structure, enabled a higher extractability of the contained substances. Surprisingly, CF was constant throughout processing and only increased significantly after the leaves were finally dried. This might have been caused by a higher extractability of dried tea.

Table 2. Mean values of total catechin content TCC (g per 100g DM), total polyphenol content TPC (as gallic acid equivalent g per 100g DM) and caffeine CF (in g per 100g DM) throughout black tea processing in three processing units in Wawee

	TCC	**TPC**	**CF**
Withering	6.42 ab	16.01 ab	1.50 b
Roasting	6.79 ab	15.08 b	1.48 b
Rolling	7.94 a	16.17 a	1.67 b
Oxidation	6.53 ab	12.51 c	1.67 b
Dried Tea	6.23 b	16.51 a	2.10 a

Withering, roasting, rolling: n = 72; oxidation and dried tea: n = 36. Values of the same column followed by the same letter are not statistically different (p = 0.05).

Conclusions and Outlook

Implementation of tea processing procedures in Wawee was based on personal intuition rather than on instrument based monitoring. Black tea was not produced in the usual way, as enzymatic oxidation was inhibited by roasting. The effects of enzyme deactivation before black tea oxidation were visible in the high TCC. This high TCC makes black tea in Wawee an unusual product.

The observed flexibility and intuitive handling of tea leaves were confirmed by the laboratory analyses. Moisture content varied severely within the sampling batches, especially during black tea oxidation. The final moisture content of green and black tea showed high variations and did not meet market requirements in some cases.

The TPC was lower than expected according to previous research. This might be due to the local Assam Tea variety characteristics and seasonality of tea quality. Variations of TPC throughout processing and the different sampling batches were caused by mixing of fresh tea leaf batches from different farmers. In the processing units no spatial separation of different processing procedures and tea leaf batches originating from different farmers were done.

During interviews it was confirmed that farmers do not control the leaf quality appropriately. The processing unit owners do not have strict quality control implementation either. Furthermore, in December – when samples were collected – the tea plants do not supply sufficient amounts of high quality young leaves. Harvesters pick higher quantities of old leaves of minor quality in this season. Low quality controls of farmers and tea producers also led to low levels of TCC and degraded ICC.

As a final conclusion, tea processing in Wawee did not meet international market requirements in terms of processing practices and product quality. The current product quality allows local market access only. Introducing standard protocols for the various processing steps and simple measurement equipment, e.g. for temperature and MC monitoring, could improve product quality considerably and enable access to international markets in future.

Acknowledgements

This study was conducted under the financial support of the School of Agro-Industry, Mae Fah Luang University and the project “Verbesserter Anbau und Verarbeitung von Medizinal- und Gewürzpflanzen in Nordthailand” of BMBF (Fkz.: 01DP12024). Special thanks to all the involved specialists of Mae Fah Luang University, Chiang Mai University and Universität Hohenheim and to the people in Baan Wawee who kindly cooperated with us.

References

Graham HN (1992) Green tea composition, consumption, and polyphenol chemistry. Preventive Medicine, 21, 334-350

ISO 14502-2 (2005) Determination of substances characteristic of green and black tea – Part 2: Content of catechins in green tea – method using high-performance liquid chromatography. International Standard Organization, Switzerland

Muthumani T, Senthil Kumar RS (2007) Influence of fermentation time on the development of compounds responsible for quality in black tea. Food Chemistry, 101, 98–102

Rusak G, Komes D, Likic S, Horzic D, Kovac M (2008) Phenolic content and antioxidative capacity of green and white tea extracts depending on extraction conditions and the solvent used. Food Chemistry, 110, 852–858

Theppakorn T, Wongsakul S (2012) Optimization and validation of the HPLC-based method for the analysis of gallic acid, caffeine and 5 catechins in green tea. Naresuan University Journal, 20 (2), 1-11