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FACULTY OF AGRARIAN

With the right of manuscript

Shorena Chakvetadze

Getting different types of tea products by using traditional and non-traditional raw materials

Speciality 0104- **Products Technology**

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AN ABSTRACT

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The work has been conducted at the faculty of Agrarian, Department of Subtropical Crops Products Technology of Akaki Tsereteli State University

Research Supervisor:
Makvala Pruidze - Candidate of Technical Sciences, Academic Doctor of Technology, Professor.

Doctoral programme "Agronomist Nutrition Products Technology and Expertise" Supervisors:
Keteven Kintsurashvili - Academic Doctor of Technology, Professor.
Makvala Pruidze - Candidate of Technical Sciences, Academic Doctor of Technology, Professor.

Opponents:
Temur Revishvili – Director of the Institute of Tea, Subtropical Crops and Tea Industry of Agrarian University of Georgia, Head of Engineering-Technological Laboratory, Chief scientist, Doctor of Technical Sciences, Academician of the Academy of Agricultural Sciences of Georgia.

Maria Silagadze – The acres of Akaki Tsereteli State University, Doctor of Technical Sciences, Academician of Georgian Engineering Academy.

The defence of the dissertation will take place on 29.06 2018, 14⁰⁰ at the meeting of dissertation board of the Faculty of Agrarian, at Kutaisi Akaki Tsereteli State University. Address: Block I, room 1114, 59 Tamar Mepe Str., Kutaisi, 4600.

The dissertation will be available from the library of the Faculty of Humanities at Kutaisi Akaki Tsereteli State University (59 Tamar Mepe Str., Kutaisi, 4600)

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The secretary of the Dissertation Board,
Professor V. Kob - /V. Qobalia/

General Overview of the Research

The actuality: due to the economi circumstances in our country tea industry and produced products have been significantly reduced, while it used to hold the 5th place among the leading tea producing countries. This field had a strong industrial infrastructure and scientific –technical potential and the majority of product wa exported.

Tea plantations including 64,5 thousand hectare have gone down to 47,3 hectares. But today, this data has not been verified yet, as it is constantly changing. A significant part of the plantations has gone wild, other parts have been removed and the production from the remained plantations has been diminished.

Lately, the demand for tea products enriched with polyphenolic compounds has increased dramatically. It is determined that this particular compound,both rusted and rust-resistant forms contained high anticarcinogenic character. (Jen-kun Lin, Yu–Chih Liang, 1999

Improving the quality of products, increasing its biological values and enlargement of assortment is possible by using non-traditional compounds that still remain to be the most important tasks in tea production.

In order to use Georgian tea plantations effectively, it's necessary to improve tea production and challenge local tea production , that will assist to meet the requirements of inner market demands and export potentials of the country.

Having done some activities, nowadays, it's possible to produce high taste quality Georgian tea products.

It's of great importance to study physico-chemical properties of modern product, in order to rehabilitate weed-infested tea plantations and focus on increasing employment and improving social- economic environment.

That's why we think that it's possible to carry out qualitative and quantitative research of Georgian tea products for its complete usage; tea enrichment with phenolic compounds and non-traditional nutritious herbs and berries; working out receptors for producing different new types of tea products.

The novelty of the research. Georgian tea product market has been scientifically proved and experimentally studied for the first time; conditions of tea plantations, including weed-infected ones in Georgian regions – Samegrelo, Imereti; physico-chemical properties of modern tea products; technological schemes of producing tea product which is enriched with non-traditional plants; tea production by traditional products and their processing stages; rusting level of phenolic compounds on each processing stage and its rust coefficient.

$$K_{rust} = \frac{\text{catechin rusting products}}{\text{unrusting catechin}}$$

$$K_{extr} = \frac{\text{the number of water soluble pheonolic materials\%}}{\text{with the number of water soluble pheonolic materials\%}}$$

Extracts of Georgian and foreign tea products and extract excretion: tea extract coefficient K extract= the number of water-insoluble phenolic materials%; plant products with berry supplements and enriched with phenolic compounds and vitamins (dog-rose, hawthorne plant, cranberries, mulberry, elaegnus, blackberry, raspberry, pyracantha,), herbal supplements (mint, chamomile, hypericum perforatum, cotinus) and quality indicators of floral natural aromatic compound (rose, jasmine) and tea products receptors with non-traditional compounds

The purpose of the research is to: study Georgian tea product market; research the conditions of Georgian tea plantations, estimate the number of tea plant raw material base according to the regions; to determine chemical properties of modern crude material; to choose technological schemes to produce different types of tea product, to produce tea crude material completely, its enrichment with different raw materials containing healing and useful substances (herbs and fruit-berry), technological processing of ground and packaged tea bags products, producing receptors for different types of tea, studying some main chemical substances of berry raw materials and drying parameters in natural circumstances and by using infrared rays.

Research tasks: to fulfill the given tasks we have done the following:

- Studied the tea crude material base in Georgia ;
- Investigated physico-chemical properties of modern raw material;
- Chose the appropriate technological regulations for its full usage;
- Enriched tea products with biologically active non-traditional raw materials;
- Created a new tea assortment;
- Researched quality indicator of different assortment products;
- Studied the conditions of tea extraction;
- Researched heat-dried tea leaves extract qualitative and quantitative way;
- Studied effects of fermentation length on the amount of water-insoluble phenolic compounds;
- Established the optimal parameters of drying non-traditional tea enrichment berries by using infrared rays;
- Created receptors for new enriched tea products .

Research object. The research object is Georgian tea production market; active and weed-infected plantations of Georgian regions – Samegrelo and Imereti; physico-chemical properties of modern tea raw materials; technological stages of tea processing; the depth of rusting phenolic compounds on each stage and its coefficient K_{rust};

The output excretion; extrusion and extracts of different types of Georgian and foreign tea products; determination of extrusion coefficient in different types of Georgian and foreign tea products K_{ext}; the rust products of water- insoluble tea phenolic compounds; plant products enriched with phenolic compound and vitamins; berry supplements (dog-rose, hawthorne plant, cranberries, mulberry, elaegnus, blackberry, raspberry, pyracantha); grass supplements (mint, chamomile, hypericum perforatum, cotinus) and floral natural aromatic compounds (rose, jasmine);tea product receptors of tea products enriched with non-traditional materials.

Practical values. According to the research carried out in Tkibuli region regarding exact hectare indicator and its suitability. We think that modern materials of 2-3 leaved tea shoots should be processed through orthodox tea production technology and its fermentation length shouldn't exceed 3-5 hours. Fermented tea dehydration is prohibited in the direct sun or in the shadow without ferment inactivation, and less quality tea material (3-5 leaved tea shoots) processing should not be carried out by thin tea production technology for 1,5-2 hours fermentation, not only in state, but also in farming enterprises.

For measuring the quality we've taken the indicators: K_{rust}. - rusting degree of phenolic compounds and K_{ext}. – tea extract degree.

We have determined the factors effecting tea extractor and studied rusting products of water-insoluble catechins. Thearubigins TR-3 and TR-4. Its amount in heat-dried tea product is about 4,2% and is considered to be a loss for the consumers.

For increasing tea product quality and its assortment, we assume that we should enrich tea with non-traditional herbs and berries which contain biologically active substances.

For its intensification we have set optimal parameters of heat-dried berries. It's possible to heat dry scattered berry crude product by using infrared rays, that increases heat-dry intensification 6-8 times compared to conventional methods.

We have confirmed new tea assortment receptors by the following equality (95:5%) or (19:1): "tea with dog-rose leaves, "tea with dog-rose fruit, "tea with red hawthorn fruit", "tea with black hawthorn fruit", "tea with red hawthorn leaves", "tea with blueberry fruit", "tea with mulberry leaves", "tea with elaegnus leaves", "tea with pyracantha fruit", "tea with raspberry fruit", "tea with raspberry leaves", "tea with raspberry leaves", "tea with lime - tree blossoms", "tea with rose petals"; by the equality of (93:7 %) or (13:1) - "tea with mulberry fruit", "tea with cotinus fruit", by the equality of 92:8 (%) or (12:1) - "tea with wild blackberry fruit", "tea with cultivated blackberry fruit", „tea with chamomile", "tea with mint", "tea with hypericum perforatum.", by the equality of (96:4%) or (24:1) – "tea with jasmine petals".

Research approbation. The main findings of the research have been presented at Department of Subtropical Crops Products Technology of Akaki Tsereteli State University (2015-2018) and published in scientific international conference works.

- Makvala Pruidze, Shorena Chakvetadze - „The Classification of tea products throughout the World" , Republican Scientific – Practical conference „Young Agrarians" edition, Kutaisi, 2016, pg.36-40.
- Makvala Pruidze, Ekaterine Bendeliani, Shorena Chakvetadze – "Modern conditions of Tea Production in Georgia and the opportunities of its improvement", Sixth International Scientific Practical Internet-conference Works Edition "Biologically Safe Nutrition Problem and business Surroundings", Kutaisi, 2016, pg. 109-114.
- Makvala Pruidze, Shorena Chakvetadze, Ekaterine Bendeliani - "Tea beverage enrichment with bioactive supplements", International Practical conference "Modern Pharmacy-science and Practice", works, Akaki Tsereteli State University, 207, pg. 23-27.
- Kakhniashvili Ekaterine, Chakvetadze Shorena - „Economic Effectiveness of Tea production Enriched with Herbal Supplements", Fourth International Scientific Practical Internet-Conference work Edition "Biologically Safe Nutrition Problems and Business Surroundings", Kutaisi, 2014, pg.129-133.

The main concepts of the dissertation are published in 14 periodical scientific works in Georgia and abroad.

Research volume and structure. The dissertation is 195 pages long and consists of 5 chapters. It includes the list of 243 used literature resources following by 43 timetables, 16 drawings and 22 photos.

Chapter I. General overview

In this chapter we focus on contemporary circumstances of tea production in Georgia and in the world, tea production in the world, tea production in Georgia, tea production classification, tea quality and its influence on human, classification of phenolic compound of tea and herbal crude products, antioxidant qualities of phenolic compounds, vitamins and their significance, biochemical ways of tea processing, factors effecting tea extractor, botanical and morphological features of tea product supplements, their role and importance for human body and its use in catering industry, botanical and morphological features of floral supplements (rose, jasmine, lime tree), herbal supplements (mint, chamomile, hypericum perforatum, cotinus), botanical and morphological features of berry supplements (dog-rose, hawthorne plant, cranberries, mulberry,elaegnus blackberry, raspberry, pyracantha).

Experimental part
Chapter II. Research object and methods

Technological and biochemical researches and lab experiments are carried out in the lab of Department of Subtropical Crops Products Technology of Akaki Tsereteli State University, Faculty of Agrarian. The main research object is Georgian tea product market; active and weed-infected plantations of Georgian regions – Samegrelo and Imereti; physico-chemical properties of modern tea plants; technological schemes of producing tea product, tea processing stages by using traditional crude products ; the depth of rusting phenolic compounds on each stage and its coefficient Krust; The output of extrusion and extracts of different types of Georgian and foreign tea products; determining tea extract coefficient K_{ext}, rusting products of water-insoluble tea phenolic compounds, herbal crude products enriched with phenolic compounds and vitamins; berry supplements (dog-rose, hawthorne plant, cranberries, mulberry, elaegnus, blackberry, raspberry, pyracantha); herbal supplements (mint, chamomile, hypericum perforatum, cotinus) and floral natural flavoring (rose, jasmine); receptors for new types of tea product enriched with non-traditional raw material,

During the research process we've utilized the following methods: determining water and solid materials by thermogravimetric method, extract materials by disposable extraction and their heat-drying, phenolic compound consistency by Levental method (5,82); chromatography accelerated method on a thin layer; determination of number of dissolved cells; defining caffeine by spectro photometric method; double Spectrophotometric method; defining number of essential oil by Ginzberg method; DPPH method of determining antioxidant activity; Method of determining the total number of flavonids with AlCl3 react; Spectral method Spectral method of determination of chlorophyll and carotenoids, catechins; PH method of measuring the total number of monomeric anodes.

Chapter III. Research of Georgian modern tea crude material

Together with the other data, tea production and consumption is determined by tea chemical constituents and properties. Tea consists of rich chemical constituents, such as Alkaloids-3-5%, phenolic compounds-25-30%, vitamins, essential oil, minerals, amino acids, carbohydrates, protein substances and so on.

Its clear from the evidence, that tea plantations and their products are in great danger. Our research aim was to study Georgian regional tea crude materials, plantation conditions, chemical constituents of the product, and its enrichment with different herbal supplements.

3.1 Crude base study in Samegrelo and Imereti

We have studied the number of active and weed-infected plantations and crude materials in Western Georgia, particularly in Samegrelo and Imereti regions. Samegrelo region – Zugdidi, Tsalenjixa,Chxorotsyo, Khobi and Senaki. From Imereti region – Khoni, Tskaltubo, Tkibuli, Tchiatura and Sachkhere . Tkibuli tea plantations have been studied according to related subjects.

3.1.1. The Quantitative study of tea plantations in Samegrelo and Imereti regions

Nowadays, the total area of plantations in Samegrelo is 1700 hectare. (source - Geostat). Today, the majority of plantations is deforested and weed - infected.

Tea production is one of the important fields in Imereti economical circumstances. The priorities of tea production remain their significance in socio-economic developments of the region. Tkibuli is unique with its natural features for producing high quality products. The products with chemical- organoleptic properties are particularly different from those produced in other regions and meet the international standard requirements. The vast area of tea plantations is weed-infected, but it's possible to reconstruct it.

From Imereti region we have studied Tkibuli tea plantations according to the related topics. The results are given in the chart 1.

From the research, in case of rehabilitation of 1294h. weed-infected plantations tea products will be increased. The same thing can happen throughout the whole country.

Existing plantations in Tkibuli region
By topic

Chart 1

№	Name of the topic	Plantations		Operating plantations	Growing plantations
Gurna		Existing	remained		
1	Gurna	98	50	25	25
2	Kikhoreti	27	15	8	7
3	Tsikhia	35	31	15	16
4	Boboti	17	12	7	5
5	Nadzva	7	4	2	2
6	Koreeti	16	11	5	6
7	Kitkhiji	17	12	7	5
8	Antoria	11	8	5	3

In total :		**228**	**143**	**60**	**83**
Orpiri					
1	**Orpiri**	102	79	71	8
2	**Naboslevi**	40	31	24	7
3	**Koka**	21	16	5	11
4	**Qveda Tchkepi**	25	19	14	5
5	**Zeda Tchkepi**	27	22	16	6
6	**Mandikori**	29	23	17	6
7	**Shukeli**	17	15	12	3
8	**Lafeti**	14	13	9	4
9	**Jonia**	15	14	12	2
10.	**Okhomira**	5	3	2	1
In total:		**295**	**235**	**182**	**53**
Khresili					
1	**Khresili**	386	139	30	109
2	**Legva**	131	55	7	48
3	**Akhaldaba**	30	23	10	13
4	**Gadagma Tskalwitela**	36	24	6,5	17,5
5	**Gadmogma Tskaltsitela**	67	38	5	33
6	**Bueti**	184	70	12	58
In total:		**834**	**349**	**75**	**274**
Satsire					
1	**Satsire**	738	31	16	15
2	**Zedubani**	192	17	9	8
3	**DAbadzveli**	389	26	18	8
4	**Dzirovani**	361	56	31	25
5	**Bziauri**	58	3	3	0
6	**Mantchiori**	25	-	-	-
7	**Samtredia**	225	8	5	3
8	**Axalsopeli**	350	18	9	9
9	**Ivaneuli**	32	16	7	9
In total:		**237**	**175**	**83**	**92**
Jvarisa					
1	**Jvarisa**	432	140	47	93
2	**Ojola**	256	97	20	77
3	**Khorchana**	71	29	20	9
4	**Lekereti**	28	19	12	7
5	**Lashia**	32	24	9	15
In total:		**819**	**309**	**108**	**201**

Kursebi					
1	**Kursebi**	94	51	20	31
2	**Gelati**	43	34	11	23
3	**Gelati settlement (Magaro)**	19	13	4	9
4	**Motsameta**	17	10	3	7
In total:		**173**	**108**	**38**	**70**
Sochkheti					
1	**Sochkheti**	576	229	53	176
2	**Tsknori**	346	136	47	89
3	**Dzmuisi**	252	125	25	100
In total:		**1174**	**490**	**125**	**365**
Tsutskhvati		82	71	60	11
1.	**Bueti**	184	70	8	62
2.	**Dzuknuri**	231	94	12	82
In total:		**415**	**164**	**20**	**144**
1.	**Mukhura**	**132**	**24**	**12**	**12**
In total in Tkibuli region		**4307**	**1997**	**703**	**1294**

3.1.2. Physico-chemical indicators of modern tea crude products in Samegrelo and Imereti

From weed-infected plantation we have harvested 1-7 leaved tea shoots, that was divided into 1-2, 3-4 and 5-7 leaved crude products. We have studied chemical properties of tea crude products in Samegrelo and Imereti region. They are given in the chart 2,3.

Chemical indicators of 1-2 leaved tea shoots in Samegrelo and Imereti regions meet baiho black and green tea production requirements and it's possible to produce high-quality tea product.

The comparative analysis of 1-2 leaved tea shoots from active and weed-infected plantations in Samegrelo and Imereti regions have revealed that the quality of weed-infected plantations possess less chemical constituents. (chart 2).

Tea crude products from active and weed-infected plantations meet the requirements of black and green tea production standards and it's possible to use it for making tea products.

Chemical constituents of 3-4 leaved tea shoots which were harvested from weed-infested plantations were less in comparison with those from active plantations. The chemical structure of 5-7 leaved tea shoots from weed-infested plantations has dramatically decreased in comparison with upper part of the tea shoot. It's possible to produce tea products with the help of plant supplements.

Physico-chemical indicators of 1-2 leaved tea shoots in Samegrelo and Imereti regions

Chart 2

№	Specimen	Humidity %	tannin %	Extract materials %	Caffeine %
			Samegrelo Region		
1	**Zugdidi**	72,3	18,42	37,67	2,27
2	**Tsalenjikha**	75,14	19,15	39,05	2,32
3	**Chkhorotsyu**	75,62	19,27	38,18	2,30
4	**Khobi**	73,33	17,98	37,24	2,23
5	**Senaki**	74,28	18,92	38,6	2,25
			Imereti Region		
1	**Khoni**	76,1	20,77	39,14	2,63
2	**Tsyaltubo (Opurchkheti)**	76,8	26,2	41,52	2,8
3	**Tyibuli (Orpiri)**	77,6	24,62	39,41	2,71
4	**Chiatura**	78,2	25,18	39,09	2,68
5	**Sachkhere**	75,9	24,57	39,11	2,58

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Chemical composition of raw materials of Samegrelo and Imereti regions 5-7 from planted gardens in foliage sprays

Chart 3

№	Specimen	Humidity %	tannin%	Extract materials %	Caffeine %
			Samegrelo Region		
1	**Zugdidi**	70,8	13,35	29,18	1,67
2	**Tsalenjikha**	71,02	14,44	30,85	1,81
3	**Chkhorotsyu**	69,19	13,98	30,98	1,75
4	**Khobi**	68,28	12,07	30,09	1,51
5	**Senaki**	67,94	12,02	30,78	1,52
			Imereti Region		
1	**Khoni**	69,99	13,14	29,17	1,65
2	**Tsyaltubo (Opurchkheti)**	70,7	14,48	30,56	1,81
3	**Tyibuli (Orpiri)**	70,15	13,88	30,78	1,74
4	**Chiatura**	69,87	13,32	30,21	1,67
5	**Sachkhere**	70,45	14,1	30,69	1,77

3.2. Changing chemical structure of many-leaved crude tea according to process stages

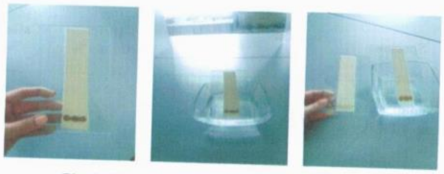
We have studied chemical structures of 3 leaved tea shoots according to season (June – August), regions (Samegrelo, Imereti) and processing stages from active plantations.

The chemical analysis of processing modern crude tea of 3 leaved shoots have revealed that crude contains enough phenolic compounds 18,91% and extract materials 38,4%, that slightly lags behind the chemical constituents of 2-3 leaved tea shoots. This indicates that high quality black and green tea products can be received from modern crude tea.

According to process stages, total amount of phenolic compound (Tannins), total amount of catechins,

Catechin rusting products and Catechin rusting coefficient, are determined not only in basic crude but also in tea leaves.

In order to regulate fermentation process we have studied a number of changes in catechin tea phenolic compounds and their rusting products. The number of non-rusting catechin and its rusted products have been determined by chromatography method (pic.1).



Pic. 1. Chromatography of the cellulose thin layer

On a cellulose thin layer, tea extract of 0.2ml amount , was in the process of 2% acetic acid chromatograph, catechin fraction was eluded by 80% spirit, as for catechin rusting products by 60% acetone. Their amount is determined by colour intensity on photoelectric colour detection in relation with vanilline reactor.

In the tea leave fermentation process with various exposition tea catechin amount, catechins rusting products Theaphylene and Theorubines were determined. Catechin rusting coefficient (K_{rust}) with the following formula.

$$K_{rust}=\frac{\text{catechin rusting products}}{\text{unrusting catechin}}$$

Catechin rusting coefficient reveals rusting depth of fermentation process and it represents chemical properties for black tea products. If black tea is qualified catechin rusting coefficient approaches 1 or equals it. Catechin rusting coefficient can be changed up to 0,1-9.

From chart 4 it's evident that while crude processing the number of rusting products and catechins were changed in accordance with the stages. Decreasing the number of catechins caused the increase of rusting coefficient. K_{rust} coefficient is for soft (1-2 leaved) and rough (5-7 leaved) crude 1,11 or 1,48.

The result analysis, according to catechin rusting coefficient, shows that tea product K_{rust} through different quality crude varies from 1,2 - 1,53 , and it indicates the direct correlative attitude of catechin rusting to tea quality (chart 4)

Changes of phenolic compound in many-leaved tea plant crude while producing black tea (active and weed-infected plantations)

Chart 4

№	specimen	Total amount of phenolic compounds (Tannin %)	Total amount of catechins mg/gr	Theaphylene and Theorubines mg/gr	K= cat. rust. prod. / catechins
	1-2 leaved				
	Samegrelo (Tsalenjikha)				
1	Green leaf	19,15	94,13	-	-
2	Withered leaf	17,88	87,15	-	-
3	curved leaf	17,90	63,08	73,22	1,16
4	Fermented leaf	16,57	50,87	61,21	1,2
5	Dried n/f	14,23	32,12	41,76	1,3
	Tskaltubo (Opurchkheti)				
1	Green leaf	26,28	104,42	-	-
2	Withered leaf	24,51	95,14	-	-
3	curved leaf	23,17	72,33	79,98	1,11
4	Fermented leaf	20,64	60,54	69,42	1,15
5	Dried n/f	18,38	51,54	61,85	1,2
	3-4 leaved				
	Samegrelo (Tsalenjikha)				
1	Green leaf	18,94	91,94	-	-
2	Withered leaf	17,33	80,38	-	-
3	curved leaf	16,19	66,14	76,89	1,16
4	Fermented leaf	15,54	52,05	63,15	1,21
5	Dried n/f	13,11	37,51	49,14	1,31
	Tskaltubo (Opurchkheti)				
1	Green leaf	18,6	92,88	-	-
2	Withered leaf	17,9	86,16	-	-
3	curved leaf	16,33	65,25	74,68	1,14
4	Fermented leaf	15,71	49,19	60,56	1,23
5	Dried n/f	14,48	40,80	51,00	1,25

5-7 leaved					
Samegrelo (Tsalenjikha)					
1	Green leaf	14,44	80,03	-	-
2	Withered leaf	13,89	67,17	-	-
3	curved leaf	13,25	52,59	60,01	1,14
4	Fermented leaf	12,12	30,10	40,23	1,34
5	Dried n/f	10,38	20,66	31,61	1,53
Tskaltubo (Opurchkheti)					
1	Green leaf	14,78	81,39	-	-
2	Heated leaf	13,76	80,02	-	-
3	curved leaf	12,31	71,34	22,27	0,31
4	Fermented leaf	11,93	49,11	36,45	0,74
5	Dried n/f	10,05	34,54	51,12	1,48

For different types of tea products, comparative numerical analysis of rusting products showed that chemical properties of tea products from Imereti region (Opurchxeti) are slightly higher than in the products produced in Samegrelo (Tsalenjikha). It indicates that rusting coefficient can be used as an important chemical indicator together with organoleptic indicators.

According to the chemical properties of the crude from Samegrelo and Imereti regions and the teatester indicators it's possible to get black and green baiho tea from 1-2 leaved and 3-4 leaved tea shoots, as for the tea product made from 5-7 leaved crude can be used for producing compressed or brick tea, granulated and packaged teabags.

3.2.1. Different types of tea extract and some influencing factors

In order to determine the influencing factors of extract process, different amounts of tea products from a number of different countries have been taken and extracted by someclassical techniques (Vorontsov, Eder, teatester teatester brewing). These techniques vary from each other mainly from ratio of water and tea brewery, and the amount of extract and its length. To identify the exact extract level, tea brewery has been extracted three times by using the three types of techniques to get the comparative analyses.

The extract of one and the same kind of tea through different techniques in accordance with extract number is consequently lower. Maximal amount of extract

can be received by Eder method , as for Vorontsov method - less amount of extract is received and even less by teatester brewing. (pic. 2)

Pic.2. Teatester extracts of different types of tea

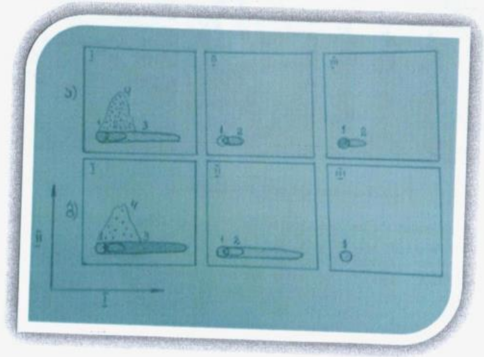
On average, the loss of tea extract for the users in the process of teatester is the following: 1) for Georgian leaf tea - 4,13%; 2) for Georgian thin tea - 2,68%; 3) packaged tea - „**Greenfild**"- 3,98%; 4) for thin tea - „**TWININGS-ENGLISH BREAKFEST**" - 4,4%; 5) for Ceylon thin tea - „**Dimbula**"- 5,24%; 6) Chinese, light colour, Oolong - „**TIEGUANYIN**'' - 6,7%. Thus,. It depends on tea crude and the types of productions, the level of rusting of phenolic compounds. On average, for any kind of tea liquid the loss is about 4,52 %.

In order to get rid of the loss, it's better to brew tea product three times.

3.2.2. Qualitative and quantitative analysis of water insoluble catechin rusting products

After three times of extraction, the brewed tea leaf possesses brown coloring as it is characteristic for phenolic compound rusting products. Our research goal is to define qualitative and quantitative indicators of brewed tea leaf coloring.

We have taken tea samples given through different techniques - brewed leave after three-times extraction. (Vorontsov - 1, Eder method - II, teatester method - III) The samples dried, and 1,5gr. and 10ml 70% acetone was added to those samples which were of equal weight, while stirring intensively, it was filtrated up to 10ml of the liquid. After that we have taken the 0.2 ml of acetone eluate and placed it on a sheet of chromatographic paper FN-16 size of (30X30). The analysis of two-dimensional chromatography was carried out in the solvent systems: I direction : N – butyl alcohol: icy acetic acid:water - (4:1:5), II direction – 2% icy acetic acid. After the chromatographic paper was dried, it was processed by different reactors. All the material which appeared on chromatography had the pink coloring with vanilla reactor This is characteristic for phenolic compounds. The majority of the materials obtained in tea product by two-dimensional chromatography has brown coloring and is different from other phenolic compounds and existing evidence (pic. I).



Pic.1. Chromatographic scheme of brewed tea leaf acetonic extract

By qualitative and R_f analysis of the materials on chromatography it's clear that after three-times extrac tion of a tea leaf there aren't any catechins and low molecular rusting product traces. Such as: theaflavins (TF), also thearubigins (TR), thearubigin 1(TRI), and thearubigin 2 (TR2),

According to the length of fermentation, after a short three-times extraction only thearubigin 2 (TR2) and thearubigin 3 (TR3) stay in fermented tea brewing. But after a long fermentation (3-5hours) thearubigin 2 (TR2) declines and thearubigin 3 (TR3) and thearubigin 4 (TR4) increase.

Therefore, we've decided to determine the tea extract output and extraction coefficient of tea product on Georgian market. For this reason, only 70% acetone in brewed tea leaf was taken out and the rest was catechines rusting products.

Characteristics of the materials on the chromatography

Chart 5

Material Indication	R_f indicator		Material Coloring on chromatography						
	Solvent system		Without processing		processing NH_3		$AlCl_3$ 1% alcohol		1% vanilla solvent b cont. HCl
	I б But. Alcohol. : acy.acid: water 4:1:5	II 2% acid.	visible	invisible	visible	invisible	visible	invisible	
1	0	0	brown	brown , chocolate color	Darkened	brown	brown	brown	-
2	0-0,14	0	Light brown	Chocolate brown	Darkened	brown	Light brown	brown	pink
3	0-0,43	0	Light brown	Light chocolate brown	Darkened	-	-	brown	pink
4	0-0,9	0,23-0,9	Slight brownish	-	Darkened	-	-	-	pink

Acetone medication which was received from dried tea leaf has been removed and only solid material was determined in grams . We have received K in the balance with some water soluble phenolic materials, that was called extract coefficient

$$K_{extr} = \frac{\text{the number of water soluble pheonolic materials\%}}{\text{with the number of water soluble pheonolic materials\%}}$$

The indicator is changeable and it depends on tea plant quality and the length of fermentation.

The less K_{extr} coefficient numeric value is and reaches 1, the less fermented and high quality tea product is. K_{extr} can be used as one of the chemical indicators of tea quality and it is shown in its numeric indicators.

In order to increase the quantity of tea product, assortment and quantity indicator, we have decided to enrich tea product and produce new products using different herbal non-traditional supplements.

Chapter 4. Tea production with herbal crude

Studying physico- chemical and organoleptical indictors of modern crude and its products has revealed that quality indicators such as: Extract materials, Phenolic compounds, Alkaloids and so on, have been declined in tea plant crude in comparison with the last year data. In order to increase tea quality and numeric indicators it's better to enrich it with non-traditional crude.

4.1. Studying the chemical indicators of rose petals

Our aim is to flavor black and green tea with raw and dry rose petals, to enrich it with phenolic and other materials. We've taken different types of rose petals, which were determined by their dryness, phenolic compounds, extractness, essential oils and flavor with organoleptic indicators. The determination of physico-chemical indicators of rose petals carried out in newlypicked and dried crude, as the rose petals were not significantly different from their physico-chemical indicators except the level of their dryness and flavor. That's why the rest of the analysis were performed on dried rose petals.

Rosa centifolia and *rosa damascena* have the best chemical indicators, that can be used in tea product as a flavor and as a supplement.

4.2. Studying physico-chemical indicators of berry and herbal crude

We have chosen unconventional tea crude (tea shoots and 7leaved buds), it has been converted into black and green (thin tea) under lab conditions. Dog-rose, hawthorne plant, cranberries, mulberry, elaegnus, blackberry, raspberry, pyracantha mint, chamomile, hypericum perforatum, cotinus raw leaves and their fruit were added to it.

Tea product enriches with biologically active herbal supplements and vitamins - C, B, P, PP,phenolic compounds and so on. The number of extract

materials of different herbal supplements varies from 25,5 to 55%, and as for total phenolic compounds it's 7,28-25,66%.

4.2.1. Study of chemical composition in Cotoneaster pyracantha l

The study of chitvashilas extractive substances, their antioxidant activity, phenolic compounds, flavonoids, catechins, phenols and carotenoids (Table 6) have been studied.

Chemical composition and antioxidant activity (%)

Chart 6

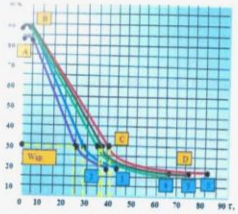
Cotoneaster pyracantha l	Extract %	Antioxidant activity		Phenolic compounds	Flavonoids	Cateches	Phenolarbone acids
		In-%	Dilution factor F				
Water extract	37,68	68,46	25	22,69	15,86	4,56	2,55
40% ethanol extract	39,54	63,7	50	68,8	37,45	7,85	5,37
80% ethanol extract	37,4	56,38	2	45,28	14,23	6,01	4,05

Chart 6 shows that Chaitivashala extracts are characterized by high heights (63-68%). Also in Cotoneaster pyracantha l were the total number of chlorophyll (135,63 mg / 100g), β carotene (254,11 mg / 100g) and lycopene (91,66 mg / 100g).

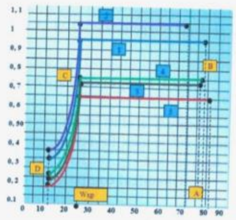
4.2.2. Determining the optimal parameters of drying berries tea under infrared heating

We have studied the optimal parameters and some influencing factors of drying berries tea under infrared heating. For this process the infrared radiation laboratory dryer was used.(pic.3)

As a result, drying berries by infrared devices is characterized by certain characteristics, that's the same for every kind of berries and this is confirmed by curve analysis of optimal parameters.(pic.2,3)



Pic. 2. Drying berries under infrared heating



Pic.3. Speed curves of drying berries under infrared heating

Pic.3. Drying berries under infrared heating in laboratory dryer

Drying process of berries under infrared heating is quite pissible and perspective. The intensification is 6-8 times more in comparison with the existing drying method. The number of material loss is declined but the quality, tea tasting characteristics, storage and its stability get better.

4.2.3. Researching chemical constituents of cotinus leaves

We have studied different cotinus crudes: fresh leaves according to seasons, their sequences both in raw leaves and fixed ones. We have determined the organoleptic indicators and maximal chemical constituents revealed in July and August, extractness ranged up to 32,18-36,57, Tannin – up to 23,14-25,28 and vitamins up to C 92-104mg%.

It has been established that extracellular leaves, phenolic compounds, flavonids, catechins, phenolarbone acids and their antioxidant activity have been established. With the increase of leaf age their antioxidant properties (59,69-64,43%) and the number of anticoagulants (233,44 mg) increases.

Cotinus is regarded to be enriched with phenolic compounds and therefore, it's possible to use it as a supplement.

4.3. Tea aroma flavored with rose and jasmine supplement

Some experiments were carried out in the Lab in order to establish the parameters for producing aromatic tea. We have used rose and jasmine scented petals for flavor. The process of tea flavoring is done by coupage.

The fragrance process of raw and dried leaves was carried out, and in order to determine the optimal quantity of the petals, we have chosen dozes with different weights, aroma dozes included only 10% of 4,5 tea plant weight. The best tea proportion with rose aroma is 95:5, and as for jasmine, it's - 94:4.

4.4. Researching chemical constituents of enriched tea, organoleptic indicators and their receptors

In order to get enriched tea with herbal supplements, we've taken tea plant young tender and "deaf" shoots and 5-7 leaved shoots. Tea processing was carried out for producing black and green tea. The abovementioned supplements and fruits were added to black tea according to their weight quantities (chart 4).

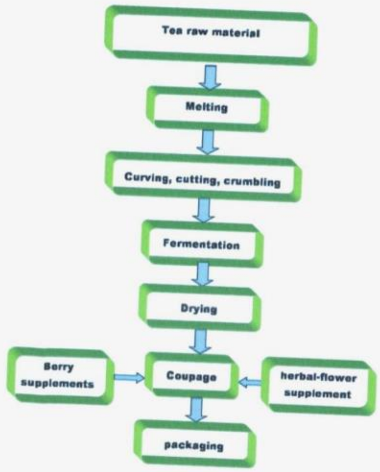
We've chosen the exact quantity of tea plant and its supplements. The chemical indicators and receptors are shown in the chart 6.

It's clear from the chart that, tea supplements were chosen according to their chemical and organoleptic indicators for improving black and green tea quality indicators.

In accordance with black and green tea receptors, we've chosen some supplements:

- Rosa leaves and fruit, red Hawthornen fruit, Hawthornen leaves, Elaeagnus leaves, Chivalry fruit, raspberry leaves and cotinus leaves – for black and green tea;

- Black Hawthornen, cranberries, mulberry, Elaeagnus and raspberry petals – only for black tea;
- Mulberry leaves, lime tree, chamomile, Hypericum perforatum, and jasmine petals only for green tea.



Pic. 4. Technological scheme for processing thin tea products by using supplements

Chemical constituents of tea products enriched with bioactive supplements (estimating from dry material)

Chart 7

№	Sample	dryness (%)	Extract materials (%)	Total quantity of phenolic compounds (%)	receptors (%)
1	Black tea		30,28	14,05	100
2	Green tea		30,56	14,62	100
3	Tea with dog-rose fruit	6,8	30,71	15,32	95:5 (19:1)
4	Tea with dog-rose leaves	6,78	30,47	14,12	95:5 (19:1)
5	Tea with red hawthorne fruit	6,5	30,5	14,06	95:5 (19:1)
6	Tea with black h Tea with red hawthorne fruit fruit	6,04	30,52	14,14	95:5 (19:1)
7	Tea with hawthorne leaves	6,52	30,33	14,17	95:5 (19:1)
8	Tea with cranberry fruit	6,11	30,84	13,93	95:5 (19:1)
9	Tea with mulberry	6,1	30,07	13,9	95:5 (19:1)
10	Tea with mulberry leaves	6,51	30,17	13,86	95:5 (19:1)
11	Tea with elaegnus fruit	6,07	31,39	13,98	93:7 (17:1)
12	Tea with elaegnus leaves	6,53	30,54	14	95:5 (19:1)
13	Tea with pyracanta fruit	6,21	30,23	13,94	95:5 (19:1)
14	Tea with raspberry	6,12	30,27	13,8	95:5 (19:1)
15	Tea with raspberry leaves	6,19	30,33	13,82	95:5 (19:1)
16	Tea with wild blackberry	5,98	29,63	13,54	92:8 (10:1)
17	Tea with cultivated blackberry	6,56	29,98	13,45	92:8 (10:1)

18	**Tea with lime tree flowers**	5,88	29,92	13,69	95:5 (19:1)
19	**Tea with chamomile**	6,33	29,82	13,41	90:10 (9:1)
20	**Tea with hypericum perforatum**	6,42	30,02	13,62	90:10 (9:1)
20	**Tea with cultivated blackberry**	6,23	29,98	14,13	90:10 (9:1)
21	**Tea with cotinus leaves**	6,5	30,68	14,48	90:10 (9:1)
22	**Tea with rose petals**	6,48	30,5	13,87	95:5 (19:1)
23	**Tea with jasmine petals**	6,65	29,99	13,75	96:4 (24:1)

However, for improving chemical and organoleptic indicators of black and green tea, we've used non-traditional materials.

Supplemented tea has enriched with biologically active and antioxidant properties of the materials – vitamins, micro elements and other useful constituents of the supplements.

Chapter 5. Economical performance account of products enriched with tea (traditional) and berries, herbal and blooming crude (non-traditional)

For determining the economical performance account material balance has been done by estimating 1 ton on each product. With quality indicators the presented products exceed the similar ones. The additional benefit through improving the average quality on each product is the following: aromatic tea 2,12 lari -1 kg; herbal tea – 7,08 lari -1kg; tea with berry fruit – 7,52 lari – 1kg.

In spite of the fact that, while producing the offered products the quality of ready- to- drink products improves too and the profitability of enterprise increases, in our case 46,33-43,96 =2,37%

Conclusions

The research conclusions that are carried out let us form the following:

1. The conditions of Georgian tea plantations (active, weed-infected and ruined) expressed in hectares don't coincide with the official data, On the basis of the research of tea plantations in Tkibuli region , that needs to be proved, it's

officially recognized, in case of restoring 1294 hectare weed-infected tea plantation in Tkibuli region, crude base will be increased. Similarly, the crude base throughout Georgia may be increased too with the help of its research.
2. According to raw material base in Imereti and Samegrelo regions, and on the research of chemical compounds of 1-2 leaved shoots taken from active and weed-infected plantations it's clear that the chemical compounds of 1-2 leaved shoots taken from weed-infected plantations lag behind the chemical compounds of 1-2 leaved shoots from active plantations: Tannin and extract materials on average by 2%, as for caffeine - 0,5%. The chemical compounds of 1-2 leaved shoots meet all the requirements of processing Baiho black and green tea and it's possible to produce high quality ready-to-drink tea.
3. Comparative analysis of chemical compounds in 3-4 leaved shoots taken from active and weed-infected plantations show, that the chemical compounds of crude from weed-infected plantations is less than those from active plantation. It's possible to get average quality black and green tea.
4. Different kinds of tea products enriched with non-traditional herbal bioactive materials can be received by 5-7 leaved shoots taken from weed-infected plantations.
5. It's proved that from physico-chemical indicators tea plant from Tsalenjixa and Opurchxeti was exceptional. Black tea was produced from this crude by schemes of orthodoxal technology of thin tea production. Main chemical indicators and rusting coefficients were established , as one of the chemical indicators of quality $K_{rust} = \frac{\text{catechin rusting products}}{\text{unrusting catechin}}$.
6. We have studied qualitative and organoleptic properties of Georgian and foreign tea products existing on Georgian market. We have determined the factors influencing extract excretion (extract sequences, length, proportion between water and tea). Extract excretion increases with the number of steeping, which is proved by examining phenolic compounds of rusting products on a steeped leaf.
7. In order to avoid loss of extract substances while consuming tea products, it's advisable to steep tea plant three times. In case of single extraction, the number of lost extract substances is about 4,52%.
8. The rusting products of phenolic compounds on a steeped leaf were studied by 70% acetone eluate piece of paper through double chromatography. It appeared that catechins rusting high molecular substances stay on a steeped leaf – thearubigin 2(TR2), thearubigin 3(TR3) and thearubigin 4 (TR4), that

hardly or even don't dissolve in water and therefore, it's not a loss for consumers.

9. It's proved that according to the length of fermentation, after triple extraction (1,5-2hours) only thearubigin 2(TR2) and thearubigin 3(TR3) stay on a fermented steeped tea liquid, but after a long fermentation (3-5 hours) only thearubigin 2(TR2) stays, whereas thearubigin 3(TR3) decreases and thearubigin 4(TR4) increases.
10. The coefficient of water soluble rusting products of phenolic compounds, thearubigin 4(TR4) have been determined.

$$K_{extr} = \frac{\text{the number of water soluble pheonolic materials\%}}{\text{with the number of water soluble pheonolic materials\%}}$$

11. Tea extractness coefficient (K_{extr}) shoes the depth of fermentation and this indicator is changeable. It depends on tea plant quality and the length of fermentation. The less K_{extr} coefficient numeric value is and reaches 1, the less fermented and high quality the tea product is. Tea extract coefficient K_{extr} (expressed in numbers) can be used as one of the chemical indicators of tea product quality.
12. In order to enrich low quality traditional tea product, we've studied physico-chemical indicators of non-traditional crude (leaves and fruit of dog-rose, hawthorne plant, cranberries, mulberry, elaegnus, blackberry, raspberry, pyracantha, mint, chamomile, hypericum perforatum, cotinus, rose and jasmine).
13. Extracellular substances, phenolic compounds, flavonids, catechins, phenolarbone acids and their antioxidant activities have been studied in the water and ethyl alcohol extract of the fetus. It was established that chitvashilas extracts are characterized by high inhibition, which is 63-68%.
14. Determination of the trunk leaves, phenolic compounds, flavonids, catechins, phenolarbone acids and their antioxidant activity have been established. With the increase of leaf age their antioxidant properties (59,69-64,43%) and the number of anticoagulants (233,44 mg) increases.
15. We've set the optimal parameters of heating non-traditional crude under infrared heating. (dog-rose, hawthorne plant, cranberries, mulberry, elaegnus, blackberry, raspberry fruits).
16. We've lain technological schemes of tea products enriched with non-traditional crude and new product receptors – tea with berries, herbal tea and aroma tea.
17. indicators of ready-to-drink tea products made from different quality tea crude and new products enriched with non-traditional crude.In comparison with the basic one, supplemented tea was enriched with the substances which are biologically active and have antioxidant properties – vitamins, micro elements and other useful materials that supplements contain.

18. We've worked out the receptors of black and green tea new products that are enriched with non-traditional crude with the following percentage and equity ratio. (95:5%) that's (19:1): "tea with dog-rose fruit", " tea with red hawthorne fruit", " tea with black hawthorne fruit", " tea with black hawthorne leaves", " tea with cranberry fruit", " tea with mulberry leaves", " tea with elaegnus leaves", " tea with lime tree flowers", " tea with raspberry", " tea with raspberry leaves", " tea with rose petals"; (93:7 %) or (13:1) ratio " tea with mulberry ", " tea with elaegnus fruit", 92:8 (%) or (12:1) ratio, " tea with wild blackberry", "tea with cultivated blackberry", "tea with chamomile", "tea with hypericum perforatum"," tea with mint", "tea with cotinus"; (96:4%) or (24:1) ratio – "tea with jasmine petals".
19. In spite of improving ready-to-drink product quality while processing the offered products, profit and profitability of the enterprise will increase.

The main concepts of the dissertation are given

in the following publications:

1. Shorena Chakvetadze – " Drying berries under infrared heating. Kutaisi scientific journal "Novation" # 21, Kutaisi, 2018, pg.25-30
2. Shorena Chakvetadze - „Tea production of different plant additives Using", Kutaisi scientific journal "Novation" # 21, Kutaisi, 2018, pg.37-41
3. Shorena Chakvetadze - „Chinese tea production and its classification", Akaki Tsereteli State University "Moambe", Kutaisi, 2018, pg.27-32
4. Makvala Pruidze, Shorena Chakvetadze, Ekaterine Bendeliani – "tea with rose petals", Kutaisi scientific journal "Novation" # 21, Kutaisi, 2018, pg.31-36
5. Makvala Pruidze, Shorena Chakvetadze, Ekaterine Bendeliani –" The factors influencing tea extractness", Georgian Agricultural scientific Academy, Tbilisi, 2018, pg.87-92
6. Makvala Pruidze, Shorena Chakvetadze, Ekaterine Bendeliani - "Tea beverage enrichment with bioactive supplements", International Practical conference "Modern Pharmacy-science and Practice", works, Akaki Tsereteli State University, 207, pg. 23-27.
7. Makvala Pruidze, Shorena Chakvetadze – "The influence of tea raw material quality indicators on different types of tea products", "Agro NEVS", Periodical Scientific journal N3, Kutaisi, 2017, pg. 85-89.

8. Mikaberidze M. Sh., Chakvetadze Sh. M, Pruidze M, P – "Intensification process of berries under infrared heating", Economics and agriculture, 2017,№8 20).URL: http://aeconomy.ru/science/agro/intensifikatsiya-protsessov-sushki-/
9. Makvala Pruidze, Shorena Chakvetadze, Ekaterine Bendeliani – " Investigating Modern Tea Raw Materials in Imereti and Samegrelo", agro NEVS", Periodical Scientific Journal N2, Kutaisi, 2016, pg. 113-119.
10. Makvala Pruidze, Shorena Chakvetadze - "The Classification of tea products throughout the World" , Republican Scientific – Practical conference "Young Agrarians'" edition, Kutaisi, 2016, pg.36-40.
11. Makvala Pruidze, Ekaterine Bendeliani, Shorena Chakvetadze – "Modern conditions of Tea Production in Georgia and the opportunities of its improvement", Sixth International Scientific Practical Internet-conference Works Edition "Biologically Safe Nutrition Problem and business Surroundings", Kutaisi, 2016, pg. 109-114.
12. Makvala Pruidze, Ekaterine Bendeliani, Shorena Chakvetadze – "Getting concentration under uranium dioxide pressure from Tea Plant Rough and Unconventional leaves", Kutaisi Scientific Journal "Novation" #15,Kutaisi, 2015, pg. 214-218.
13. Kakhniashvili Ekaterine, Chakvetadze Shorena – " Economic Effectiveness of Tea production Enriched with Herbal Supplements", Fourth International Scientific Practical Internet-Conference work Edition "Biologically Safe Nutrition Problems and Business Surroundings", Kutaisi, 2014, pg.129-133.