Potravinarstvo, vol. 7, Special Issue, March 2013

Available online: 20 March 2013 at www.potravinarstvo.com
ISSN 1337-0960 (online)

INFLUENCE OF MICROELEMENTS ON BIOCHEMICAL PARAMETERS OF TEA

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Abstract: The microelements brought through a leaf, allow to receive qualitative raw materials for receiving ready tea, stimulating signs genetically put in a plant at the minimum costs of their cultivation (without watering of plantations and unlimited increase in doses of macro fertilizers). Processing of plants by copper (r = 0,72), manganese (r = 0,76) and iron (r = 0,82) promote increase in raw materials of the content of tannin to 33,8 – 34,29% (on control – 30,72%) and for 0,9 - 1,4% of extractive substances (control - on the average 41,6%). The components of a leaf which are responsible for quality of finished production are dependence with brought microelements. And, dependence direct: at increase in quantity of microelements, in a plant there is an increase in qualitative characteristics.
Keywords: tea, microelements, tannins, extractive substances, caffeine

INTRODUCTION

To the middle of the 90th years the tea-growing branch in Russia was one of leading branches of agriculture. The areas of plantations exceeded one and a half thousand hectares from which more than 7 thousand tons of a green tea leaf gathered; about 2 thousand tons of ready tea was annually made. However the reorganization which has begun in the country changed situation in tea growing of Russia. As a result of an agrarian reform (1990 - 1994) catastrophic decline in production of production of tea growing began. By 2001 the branch became unprofitable, the teas areas there was a half from actually existing. However, since 2003, in Krasnodar region the Federal program which allowed not only to restore, but also systematically to develop branch started working. Today in Russia all six tea farms are kept, the tea factory at which let out tea of four grades works: red, yellow, green and black, and also tea with additives of herbs. Thus in the territory of each of six tea farms there are the small processing factories which are letting out qualitative production. All this demanded systematic studying not only biology of the plant, but also carrying out researches on selection of fertilizers for increase of efficiency, stability of culture and improvement of quality of tea.

Objects and methods of the research

Research of influence of not root top dressing by microelements (Cu, Mn, Zn, and Fe) carried out (area of 0, 4 hectares) on the basis of the experience areas which located on a tea plantation in village of Uch-Dere.

The scheme of experience included 6 variants in 4-fold frequency: control (spraying by water without microelements); solution of sulfate copper in concentration of 0,06%; manganese sulfate – 0,6%; zinc sulfate – 0,3%; sulfate iron – 0,5%; mix microelements in total concentration – 1,0%. The variants were location as randomizer.

Laboratory researches carried out in laboratory of biotechnology, physiology and biochemistry of plants of the All-Russian research institute of floriculture and subtropical cultures (Sochi). Fixing of samples for biochemical researches carried out water vapor in Koch device within 2 – 3 minutes, with the subsequent drying to an air and dry condition at a temperature of 60^0C. Extractive substances determined in the weight way by Vorontsov's

(Vorontsov, 1946), technique, tannin – on Levental`s with recalculating coefficient 5,82 (by Dzhemukhadze) **(Dzhemukhadze et al., 1960)**, caffeine – by Bertrán's method, in Kursanova's modification **(Kursanov, 1952)**.

RESULTS AND THEIR DISCUSSION

It is known that quality indicators of tea, namely, the content of extractive substances and tannins is subject to the strong variability caused by a variety of reasons. So, application on tea plantations of high doses of nitric, phosphoric and potash fertilizers positively affects productivity of plants, but reduces the content of tannic and extractive substances (Argunova et al., 1992; Gamkrelidze et al., 1966; Salukvadze, 1986; Bonheure, 1990; Robson et al., 1983). A food of plants has other impact on the content of caffeine in a tea leaf: it is established that with increase in doses of nitric fertilizers the content of caffeine increases (Gamkrelidze et al., 1966; Robson et al., 1983). We noted also influence of microelements on these indicators (Belous, 2006; Belous, 2006). So, the regression analysis of results of the first years of researches confirmed existence of correlative dependences between not root introduction of microelements and the content of caffeine in a green leaf: Y = 4,96 – 1,60Cu – 1,19Mn + 1,94Fe, R = 0,65; $R^2 = 0,42$.

Very interesting results were received when carrying out the biochemical analysis of the ready tea (semi-finished product) developed from these raw materials (tab. 1). Namely: not root processing's of plants of tea by microelement promoted some increase of the content of extractive substances (r = 0, 59) and tannin (r = 0, 65) in comparison with control. Carried out of mix of elements is led to essential increase in ready tea of the content of tannin and extractive substances. In turn, the content of caffeine in a ready-made product authentically increased when processing plants by copper and manganese. The regression analysis of 5-year data of influence of microelements on quality of ready tea is expressed by the following equations: Y = 12,5 + 0,6Cu + 1,2Zn + 2,0CuZn (for extractive substances); Y = 8,6 + 0,1Mn + 0,2Fe +0,4Cu + 1,4Zn (for tannin); Y = 1,2 + 0,2Zn + 0,5Mn + 0,8Cu (for caffeine).

Our data will be coordinated with known situation that microelements, participating in oxidizing processes during twisting and especially a tea fermentation, and, being catalysts, promote not so much to bigger education, how many decrease in losses of the substances defining quality of finished products (Belous, 2006; Belous, 2006).

Table 1: Statistical parameters of quality of tea with microelements, 1996 – 2000

Variants	Tannin, %				Extractive substances, %				Caffeine, %			
	$\bar{x}$	Sx	σ^2	V, %	$\bar{x}$	Sx	σ^2	V, %	$\bar{x}$	Sx	σ^2	V, %
Control	12,6	1,8	3,62	15,1	32,9	1,4	2,27	4,57	2,1	0,5	0,26	24,0
$CuSO_4$	14,3	2,0	4,71	15,2	34,0	1,3	2,18	4,34	2,9	0,3	0,14	16,6
$KMnO_4$	14,0	2,3	5,98	17,4	33,6	1,5	2,43	4,64	2,8	0,3	0,16	17,9
$FeSO_4$	14,5	2,2	5,68	16,5	34,3	1,2	1,76	3,87	2,2	0,4	0,23	21,9
$ZnSO_4$	14,0	2,4	6,51	18,2	33,9	1,5	2,43	4,60	2,1	0,5	0,26	24,2
Mix	14,5	2,3	6,68	17,9	34,9	2,1	4,94	6,55	2,3	0,5	0,25	22,1
HCP_{05}	1,7	-	-	-	1,5	-	-	-	0,1	-	-	-

In process of accumulation of microelements in a tea leaf we noted their considerable influence on quality indicators not only ready tea, but also raw materials. So, there was an essential increase in the content of tannin and extractive substances in a green leaf at

manganese introduction (r = 0, 70), zinc (r = 0, 79) and copper (r = 0, 84). As a result, statistical processing showed that the components of a leaf which are responsible for quality of finished goods are in close dependence with brought microelements (tab. 2). And, dependence direct: at increase in quantity of microcells, in a plant there is an increase in qualitative characteristics. Researches in the field of biochemistry of tea show that the maintenance of the main components of tea infusion (tannin, extractive substances, caffeine) are not completely is reflected by qualities of finished production which is estimated mainly on aroma and taste of infusion.

Table 2: Coefficients of pair correlation (r) between quality indicators of a tea leaf and microcells, on the average in 11 years

Indicators	Cu	Mn	Zn	Fe
Tannin, %	0,58	0,71	0,60	0,78
Extractive substances, %	0,53	0,69	0,73	0,73
Caffeine, %	- 0,61	- 0,59	- 0,64	0,72

Therefore, along with definition of chemical indicators, it is necessary to estimate and organoleptic indicators of ready tea. Approbation by tea-tester of the received ready-made product is a most simple and fast method of determination of quality of tea. At a number of shortcomings only it is possible to determine by this method shades of smells and different smacks of infusion. At a tea-tester assessment use several quality indicators from which special value give to aroma and taste.

Aroma of tea is caused by the contents in it essential oils. They contain in a green leaf and as a result of oxidizing processes during fermentation, give to tea specific aroma. At its definition all shortcomings which arise at product development are found.

Along with determination of aroma of tea, tea-tester pays special attention to determination of its taste. There is a close connection between aroma and taste in this connection, when tasting tea, except insignificant exceptions on both indicators the identical score assessment is given. The tea presented by us for tea-testers approbation, was estimated on 5 ball scale (tab. 3).

Table 3: Tea-testers assessment of ready tea, average in 11 years

Variants	Selection term	Options selection	Aroma	Taste
			In points	
Control	June	average	4,25	4,25
$CuSO_4$	June	average	4,00	4,00
$KMnO_4$	June	average	4,00	4,00
$FeSO_4$	June	average	4,00	4,00
$ZnSO_4$	June	average	4,25	4,25
Mix	June	average	3,75	3,75
Control	September	average	4,50	4,50
$CuSO_4$	September	average	4,75	4,75
$KMnO_4$	September	average	4,75	4,75
$FeSO_4$	September	average	4,50	4,50
$ZnSO_4$	September	average	5,00	5,00
Mix	September	average	4,50	4,50

All experimental batches of black tea were highly appreciated - on the average by 4, 36 points. Color of infusion was estimated as average. The tea developed from raw materials with foliar introduction of sulfate iron had the highest assessment: from 4, 25 to 5, 00 points.

Thus its infusion possessed specific aroma of kameliya that increased flavoring advantages of this tea.

Data on influence microelement on tea plants taking into account changing weather conditions were used for a further assessment of ecological plasticity of quality indicators. Thus, brought elements stabilized process of accumulation of tannin regardless of water security of plants, being a factor significantly influencing increase of quality indicators of a tea leaf, and, respectively, a ready-made product. At the same time, as accumulation of extractive substances in very small degree depends on hydrothermal conditions of vegetation.

As a result it is possible to draw a conclusion that the microelements brought through a leaf, allow to receive qualitative raw materials for receiving ready tea, stimulating signs genetically put in a plant at the minimum costs of their cultivation (without watering of plantations and unlimited increase in doses of macro fertilizers).

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