

Chemical and pharmaceutical technologies. Life safetyDOI: <https://doi.org/10.53002/109>**QUANTITATIVE DETERMINATION OF THE AMOUNT OF RUTIN IN DIFFERENT VARIETIES OF GREEN AND BLACK TEA**¹*Toleutaeva S.*, ²*Baiseitova Zh.N.*¹*NPJSC «M.Kh. Dulaty Taraz University», Taraz, Kazakhstan*²*NPJSC “Abai Kazakh National Pedagogical university”, Almaty, Kazakhstan***Corresponding author e-mail: Sabina02t@gmail.com***Author information:****Toleutaeva Sabina**, NPJSC «M.Kh. Dulaty Taraz University», Taraz, Kazakhstan, e-mail: sabina02t@gmail.com**Baiseitova Zhanasyl Nurmukhanovna**, NPJSC “Abai Kazakh National Pedagogical university”, Almaty, Kazakhstan.ORCID: <https://orcid.org/0009-0000-7942-5367>; e-mail: zh.baiseitova81@abaiuniversity.edu.kz

Abstract — This research focuses on the quantitative determination of rutin, a naturally occurring bioflavonoid, in different varieties of green and black tea. Rutin is widely recognized for its strong antioxidant, anti-inflammatory, and capillary-protective properties, making it an important indicator of the nutritional and functional value of tea. Accurate determination of its concentration is essential for evaluating tea quality, comparing different tea varieties, and assessing their potential health benefits. In this study, representative samples of commercially available green and black teas were selected and subjected to extraction under optimized conditions to maximize the recovery of rutin. The experimental procedure included sample preparation, extraction, purification, and quantitative analysis using a volumetric analytical method. The proposed method is characterized by its simplicity, relatively low cost, and satisfactory accuracy and reproducibility, making it suitable for routine laboratory analysis. Quantitative measurements were performed for each tea sample, and the obtained data were statistically processed to evaluate the reliability of the results. The analysis revealed significant differences in rutin content between green and black tea samples, reflecting the influence of tea processing, particularly the degree of fermentation, on the preservation of flavonoids. Green tea generally exhibited a higher concentration of rutin than black tea, confirming that oxidative processing reduces the content of this biologically active compound. The findings demonstrate that the proposed analytical approach provides an effective means of determining rutin in tea and can be applied in quality control, food chemistry, and nutritional research.

Keywords — rutin, green tea, black tea, bioflavonoids, volumetric analysis method, quantitative determination, antioxidants.

ЖАСЫЛ ЖӘНЕ ҚАРА ШАЙДЫҢ ӘР ТҮРЛІ СОРТТАРЫНДАҒЫ РУТИН МӨЛШЕРІН САНДЫҚ АНЫҚТАУ¹*Төлеутаева С.*, ²*Байсейтова Ж.Н.*¹*«М.Х. Дулати атындағы Тараз Университеті» КеАҚ, Тараз, Қазақстан*²*«Абай атындағы Қазақ ұлттық педагогикалық университеті» КеАҚ, Алматы, Қазақстан***Автор-корреспондент e-mail: Sabina02t@gmail.com***Автор туралы ақпарат:****Төлеутаева Сабина**, «М.Х. Дулати атындағы Тараз Университеті» КеАҚ, Тараз, Қазақстан,e-mail: sabina02t@gmail.com**Байсейтова Жанасыл Нурмухановна**, «Абай атындағы Қазақ ұлттық педагогикалық университеті» КеАҚ, Алматы, Қазақстан. ORCID: <https://orcid.org/0009-0000-7942-5367>; e-mail: zh.baiseitova81@abaiuniversity.edu.kz

Аңдатпа — Бұл зерттеу әртүрлі жасыл және қара шай сорттарындағы табиғи биофлавоноид болып табылатын рутиннің мөлшерін сандық анықтауға арналған. Рутин өзінің жоғары антиоксиданттық, қабынуға қарсы және қылтамырларды қорғаушы қасиеттерімен кеңінен танылған, сондықтан ол шайдың тағамдық және функционалдық құндылығын сипаттайтын маңызды көрсеткіштердің бірі болып табылады. Оның мөлшерін дәл анықтау шай сапасын бағалау, әртүрлі шай түрлерін салыстыру және олардың адам денсаулығына әлеуетті пайдасын анықтау үшін маңызды. Зерттеу барысында коммерциялық қолжетімді жасыл және қара шай үлгілері таңдалып алынып, рутиннің барынша толық бөлініп шығуын қамтамасыз ету мақсатында оңтайландырылған

жағдайларда экстракция жүргізілді. Эксперименттік әдістеме үлгілерді дайындау, экстракциялау, тазарту және көлемдік талдау әдісін пайдалана отырып сандық анықтау кезеңдерін қамтыды. Ұсынылған әдіс қарапайымдылығымен, салыстырмалы түрде төмен шығындылығымен, сондай-ақ жеткілікті дәлдігі және нәтижелердің жақсы қайталанғыштығымен ерекшеленеді, бұл оны күнделікті зертханалық тәжірибеде қолдануға мүмкіндік береді. Әрбір шай үлгісі бойынша сандық өлшеулер жүргізіліп, алынған нәтижелердің сенімділігін бағалау үшін статистикалық өңдеу орындалды. Зерттеу нәтижелері жасыл және қара шай үлгілеріндегі рутин мөлшерінің айтарлықтай айырмашылықтарын көрсетті, бұл шайды өңдеу технологиясының, әсіресе ферментация дәрежесінің, флавоноидтардың сақталуына әсер ететінін дәлелдейді. Жалпы алғанда, жасыл шайдағы рутин мөлшері қара шайға қарағанда жоғары болды, бұл тотығу процесі барысында осы биологиялық белсенді қосылыстың мөлшері төмендейтінін растайды. Алынған нәтижелер ұсынылған аналитикалық тәсілдің шай құрамындағы рутин мөлшерін тиімді анықтауға мүмкіндік беретінін және оны сапаны бақылауда, тағам химиясында және тамақтану саласындағы ғылыми зерттеулерде қолдануға болатынын көрсетеді.

Түйін сөздер — рутин, жасыл шай, қара шай, биофлавоноидтар, көлемдік талдау әдісі, сандық анықтау, антиоксиданттар.

КОЛИЧЕСТВЕННОЕ ОПРЕДЕЛЕНИЕ КОЛИЧЕСТВА РУТИНА В РАЗЛИЧНЫХ СОРТАХ ЗЕЛЕННОГО И ЧЕРНОГО ЧАЯ

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Аннотация — Настоящее исследование посвящено количественному определению рутина — природного биофлавоноида — в различных сортах зеленого и черного чая. Рутин широко известен своими выраженными антиоксидантными, противовоспалительными и капилляропротекторными свойствами, что делает его важным показателем пищевой и функциональной ценности чая. Точное определение его содержания имеет большое значение для оценки качества чая, сравнения различных сортов и определения их потенциальной пользы для здоровья человека. В ходе исследования были отобраны образцы коммерчески доступных сортов зеленого и черного чая, которые подвергались экстракции в оптимизированных условиях для максимального извлечения рутина. Экспериментальная методика включала подготовку образцов, экстракцию, очистку и количественный анализ с использованием метода объемного анализа. Предлагаемый метод отличается простотой выполнения, сравнительно низкой стоимостью, а также достаточной точностью и воспроизводимостью результатов, что делает его пригодным для рутинного лабораторного применения. Количественные измерения были проведены для каждого образца чая, а полученные данные обработаны статистическими методами для оценки достоверности результатов. Анализ выявил существенные различия в содержании рутина между образцами зеленого и черного чая, что отражает влияние технологии обработки, в частности степени ферментации, на сохранность флавоноидов. В целом зеленый чай характеризовался более высоким содержанием рутина по сравнению с черным чаем, что подтверждает снижение концентрации данного биологически активного соединения в процессе окислительной обработки. Полученные результаты демонстрируют, что предложенный аналитический подход является эффективным средством определения содержания рутина в чае и может быть использован при контроле качества, в пищевой химии и исследованиях в области питания.

Ключевые слов — рутин, зеленый чай, черный чай, биофлавоноиды, метод объемного анализа, количественное определение, антиоксиданты.

MAIN PROVISION

The study presents a quantitative determination of rutin content in different varieties of green and black tea using a volumetric analysis method. The proposed approach provides a simple, rapid, and

sufficiently accurate determination of rutin concentration, making it suitable for comparative analysis of tea samples. The obtained results revealed differences in the rutin content between green and black tea, demonstrating the influence of tea

processing methods on the preservation of bioflavonoids and the antioxidant properties of tea. The developed method can be applied for quality control and evaluation of tea products based on their rutin content.

INTRODUCTION

Rutin (vitamin P) is the name given to a group of biologically active substances of plant origin (bioflavonoids and polyphenols), including rutin, anthocyanins, flavones, flavanols, catechins, and others, with more than 150 compounds identified. These substances contribute to strengthening the walls of blood vessels [1].

Strictly speaking, vitamin P is not a true vitamin, since bioflavonoids do not perform essential life-supporting functions in the human body. Rather, they are plant phenolic compounds that possess antioxidant properties and exhibit capillary-strengthening activity. Rutin was first isolated in 1842 from the plant *Ruta graveolens* (common rue).

Among the biologically active substances with vitamin P activity, catechins are the most widespread in nature. They are found in particularly high concentrations in tea. A review of scientific literature revealed limited information regarding the flavonoid content of different tea varieties. Therefore, the practical significance of the present study lies in investigating the flavonoid composition of various black and green tea samples.

Compounds exhibiting vitamin P activity are widely distributed in nature. The flavonoid content of several food products is presented below [2].

Bioflavonoids act synergistically with vitamin C. They participate in the regulation of collagen synthesis and inhibit the enzyme hyaluronidase, thereby contributing to the stabilization of connective tissues and blood vessel walls. Bioflavonoids also possess detoxifying properties, enabling them to bind heavy metals and protect adrenaline from oxidation. In addition, they exhibit antioxidants, anti-inflammatory, antitumor, anti-atherosclerotic, antimutagenic, antispasmodic, hypoglycemic, wound-healing, and microcirculation-regulating effects. They strengthen capillary walls, contribute to the prevention of oncological diseases, regulate bone mineralization, inhibit aldolase and C-reactive protein, and help prevent disorders associated with oxidative stress.

Since flavonoids cannot be synthesized in the human body, they must be obtained through the diet.

A deficiency of bioflavonoids increases capillary permeability, leading to hemorrhages, general weakness, fatigue, and pain in the arms and legs.

Vitamin P and vitamin C are closely associated. Rutin reduces capillary permeability, protects them against oxidative damage, and enhances the absorption of vitamin C. By increasing capillary strength, rutin decreases edema and bleeding, thereby reducing the risk of internal hemorrhage, preventing capillary fragility, and inhibiting the formation of atherosclerotic plaques.

Compounds belonging to the vitamin P group are metabolized into phenolic acids, which are subsequently utilized by the body for the synthesis of other biologically important compounds.

Research gap. Although numerous studies have investigated the antioxidant properties of green and black tea, limited attention has been paid to the comparative quantitative determination of rutin content using simple, rapid, and cost-effective analytical methods. Most existing research relies on sophisticated instrumental techniques, such as high-performance liquid chromatography (HPLC), which require expensive equipment and specialized laboratory conditions. Consequently, there is a need for an accessible and reliable alternative method that can be used for routine analysis and quality assessment of tea products. This study addresses this gap by applying a volumetric analysis method for the quantitative determination of rutin in different varieties of green and black tea and comparing their rutin content..

Novelty statement. The novelty of this study lies in the application of a simple and cost-effective volumetric analysis method for the quantitative determination of rutin in different varieties of green and black tea. Unlike conventional studies that mainly rely on instrumental techniques, this research demonstrates the feasibility of using an accessible analytical approach for routine quality assessment. The comparative evaluation of rutin content in green and black tea provides new data on the influence of tea processing on the preservation of bioflavonoids and antioxidant compounds.

METODOLOGY

In this study, the volumetric titration method was employed. According to the analytical procedure described in the literature [3], the quantitative determination of flavonoids is based on their ability to undergo oxidation by potassium permanganate (KMnO₄).

The samples were prepared for analysis as follows: 1.0 g of each tea sample was finely ground and extracted with 50 cm³ of hot distilled water. The extraction time was 5 minutes.

For the titration, 10 mL of the obtained extract was transferred into a flask, followed by the addition of 10 mL of distilled water and 6 drops of indigo,

carmine indicator. The solution was then titrated with 0.05 N potassium permanganate (KMnO₄) until a pale-yellow endpoint was reached.

Experimental results showed that 1 mL of 0.05 N potassium permanganate solution oxidizes 3.2 mg of rutin.

Three different varieties of green tea and black tea were selected for flavonoid analysis. The weighed samples were measured using an analytical balance with an accuracy of 10⁻⁴ g. To improve the reliability of the results, all experiments were carried out in

triplicate, and the final values were expressed as the arithmetic mean of the three determinations.

RESEARCH RESULTS AND DISCUSSION

The data obtained made it possible to calculate the vitamin P (rutin) content in different varieties of green and black tea. The analytical results, based on potassium permanganate titration, are presented in Tables 1 and 2.

Table 1 - Rutin content in extracts of black tea varieties

Product	m, g	V (p-p KMnO ₄), мЛ	w, %
Nuri	1.003	2.4	2.99
Ahmad	1.005	3.8	3.83
Ceylon Karagoda tea	1.006	3.6	3.67

Table 2 - Rutin content in extracts of green tea varieties

Product	m, g	V (p-p KMnO ₄), мЛ	w, %
Te Guanyin	1.004	1.9	1.91
Gapshauer tea	1.005	2.1	2.08
Huang Cha	1.003	0.8	0.80

The calculations showed that the rutin content in the black tea samples ranged from 1.99% (Brooke Bond tea) to 3.67% (Ceylon Karagoda tea).

For the green tea samples, the rutin content varied from 0.80% (Huang Cha tea) to 2.08% (Gapshauer tea). The obtained values are in good agreement with the published literature data [4].

Based on these results, it was established that the flavonoid content in black tea is approximately 1.8-2.5 times higher than that in green tea. This difference may be attributed to the manufacturing processes, as well as to the processing and storage conditions of different tea varieties. In general, tea production involves the fermentation of tea leaves at elevated temperatures (approximately 170-180°C), and the duration of fermentation may range from several days to several months. Black tea leaves undergo a considerably longer fermentation process, lasting up to several months [5].

It should also be noted that vitamin P is readily oxidized in the presence of ascorbic acid, and high temperatures can accelerate its degradation. Therefore, foods containing both vitamins P and C should preferably undergo minimal heat treatment to preserve their biological activity. Most compounds exhibiting vitamin P activity are water-soluble; however, tea also contains fat-soluble bioactive compounds. This may explain the traditional practice of adding butter to tea

in Eastern countries, whereas milk is more commonly added in Europe.

CONCLUSION

In this study, the quantitative content of vitamin P (rutin) was determined in different varieties of green and black tea. The calculations were performed based on the results of volumetric titration analysis. The flavonoid content in the analyzed tea samples ranged from 0.80% to 3.67%. Furthermore, the results demonstrated that the concentration of flavonoids in black tea is 1.8-2.5 times higher than that in green tea. These findings confirm that black tea is a richer dietary source of rutin and other flavonoids, which are known for their antioxidant activity and beneficial effects on vascular health.

AUTHOR'S CONTRIBUTION

(taxonomy CRediT):

Toleutaeva S. – Conceptualization, Investigation, Methodology, Data Curation, Writing - Original Draft.

Baisseitova Zh.N. – Conceptualization, Validation, Methodology, Formal Analysis, Writing - Review & Editing, Supervision.

CONFLICT OF INTEREST

The author claims that there is no conflict of interest in the implementation of this study and the publication of the article.

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