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INFLUENCE OF BREWING METHODS AND CORRELATION OF DIFFERENT KINDS OF COFFEE IN BLENDS ON ORGANOLEPTIC AND PHYSICO-CHEMICAL CHARACTERISTICS OF COFFEE DRINKS

L. Deinychenko, T. Roman, T. Kravchenko

The article presents the results of the complex research regarding the influence of brewing methods and the ratio of different types of coffee in blends on the characteristics of coffee drinks.

It is determined that the organoleptic characteristics of coffee drinks change significantly depending on the quality of the blends. Thus, the blend dominated by Coffea Canephora is characterized by a mixture of sugar browning flavors with aromas of dry distillation. With an increase of Coffea Arabica in the blends, the sensitivity of dry distillation aromas decreases significantly and there is a shift of the organoleptic profile curve towards an increase in enzymatic aromas. Predominant sour and sweet notes are observed in the flavor of drinks prepared in the aeropress and coffee machine, while drinks made with the help of cezve and French press are characterized by a lower intensity of sweet and sour flavors.

The active acidity of coffee drinks decreases with increasing of Coffea Arabica quantity in experimental blends, as well as in the drinks manufactured using coffee machine and aeropress. The amount of dissolved solids in coffee drinks prepared with the help of a coffee machine is much higher compared to the same indicator for drinks prepared by other methods. The highest is the TDS of drinks prepared on the basis of a blend with the same content of Coffea Arabica and Coffea Canephora. Regarding the dynamics of the extraction level, it correlates with the dynamics of TDS changes and is explained by identical regularities.

Keywords: *coffee drinks, coffee blend, Coffea Arabica, Coffea Canephora, organoleptic profiles, pH, TDS, extraction level.*

ВПЛИВ СПОСОБІВ ЗАВАРЮВАННЯ І СПІВВІДНОШЕННЯ РІЗНИХ ВИДІВ КАВИ У БЛЕНДАХ НА ОРГАНОЛЕПТИЧНІ ТА ФІЗИКО-ХІМІЧНІ ХАРАКТЕРИСТИКИ КАВОВИХ НАПОЇВ

Л.Г. Дейниченко, Т.О. Роман, Т.В. Кравченко

Проведено комплексні дослідження впливу способів заварювання і співвідношення різних видів кави у блендах на характеристики кавових напоїв. Визначено, що органолептичний профіль кавових напоїв змінюється переважно за рахунок зміни співвідношення зерен різних сортів у кавових блендах, а pH, TDS та рівень екстракції залежать від способу заварювання кавових напоїв та хімічного складу кавових зерен.

Ключові слова: *кавовий напій, кавовий бленд, кава Arabica, кава Canephora, органолептичний профіль, pH, TDS, рівень екстракції.*

Statement of the problem. The tradition of natural coffee consumption in Ukraine today is in the process of formation: an acquaintance with new varieties, blends and methods of roasting is happening. However, over the past few years, the coffee business in Ukraine is developing rapidly, due to the development of the coffee industry, which has created and maintains demand for freshly brewed coffee and coffee drinks [1].

With increasing competition in the market, coffee shop owners are increasingly trying to attract potential guests in new ways, using interesting author's design, non-standard menus, new types of drinks and desserts, as well as new ways of coffee brewing.

Today, the coffee industry knows a large number of ways to brew coffee and each of them affects the taste and aroma of the final product, as well as the recipe for further drinks preparation. However, each of these methods has its own subtleties of cooking, which determine the quality of the final product [2]. Nonetheless, it should be noted that in addition to the method of preparation, the blend of the selected coffee will have a

significant impact on the quality of the brewed drink. The right combination of blend and brewing method determines the characteristics of coffee and its perfection for connoisseurs of coffee culture.

Review of the latest researche and publications. Methods for determining the quality of coffee vary and are evaluated differently depending on the market type. For the restaurant industry, the key characteristics are the organoleptic properties of the drinks, as well as physicochemical and technological parameters: pH, TDS and extraction level. The study of some of these indicators is devoted to the work of domestic and foreign scientists. Thus, researchers from Colombia and the United States have studied methods of brewing coffee in terms of phenomenological explanations and their impact on the physicochemical and taste characteristics of brewed coffee [3]. It was determined that despite using the same brewing methods, the quality of the finished drinks varies depending on the extraction pressure, coffee-water ratio, water quality, contact time, particle size distribution and temperature. Studies have shown that all these factors alter the removal of bioactive and volatile compounds that affect the taste profile of the drink.

Scientists from the University of Florence studied the effect of brewing methods on the chemical composition and level of coffee extraction. According to their research [4], the maximum concentration of caffeine and chlorogenic acids was found in espresso, while for filtered coffee these figures were 3–6 times lower.

Scientists from the Food Science and Quality Center of the Institute of Food Technology of Brazil studied the effect of coffee brewing methods on the transition of polycyclic aromatic hydrocarbons (PAHs) to the drink. According to the results of their research, the difference between the levels of PAHs in drinks does not depend on the brewing process and does not vary significantly depending on the degree of coffee beans roasting.

In Switzerland a study was conducted on the effect of coffee brewing method on the content of furan and its derivatives [6]. Coffee brewed on a fully automatic machine was found to contain the highest concentrations of furan and its derivatives, while instant coffee does not contain detected levels of these compounds, thus creating the least impact on consumer health. It was found that the concentrations of furan and furan derivatives when cooled to a drinking temperature (55…60 °C) decrease by 8.0–17.2% on average for different brewing methods.

Experts from Australia conducted a two-level factor experiment to identify the effects of ultrasonic treatment on the removal of coffee components during brewing [7]. Ultrasound was found to significantly increase the removal of caffeine, triglycerides and volatile compounds from coffee, while reducing

the concentration of antioxidants in the experimental drink compared to the control, especially at longer times and at higher temperatures. In addition, all ultrasound samples showed a lighter caramel color and a lower level of foaming, due to the higher content of triglycerides.

However, despite the large number of studies on the effect of brewing methods on the chemical composition of coffee drinks, most of them do not take into account the potential variability of the results depending on the ratio of different types of coffee beans in coffee blends. Given that blends have a decisive influence on the chemical composition of the drink and, consequently, on its organoleptic and physicochemical properties, it is advisable to conduct comprehensive studies aimed at analyzing the combined effect of the ratio of different types of coffee beans in blends and brewing methods on the characteristics of the coffee drink.

The objective of the research is to study the complex influence of brewing methods and the ratio of different types of coffee beans in blends on the organoleptic and physicochemical characteristics of coffee drinks.

To achieve this goal, the following tasks were set:

– to study the influence of different brewing methods on the organoleptic properties of drinks made of various coffee blends;

– to investigate the change of physical and chemical properties of coffee drinks prepared on the basis of different coffee blends depending on the method of brewing.

Presentation of the main research material. Two varieties of coffee beans were used for the study: Coffea Arabica beans, grown in Ethiopia and Brazil regions, and Coffea Canephora beans, grown in Brazil, Vietnam and India regions (GOST 6805-97). The ratio of presented beans in the coffee blends are given in the table 1.

Table 1

The ratio of coffee beans varieties in the studied blends

Name of the studied blend	The content of coffee beans variety in the blend, %	
	Coffea Arabica	Coffea Canephora
Blend 1	10	90
Blend 2	50	50
Blend 3	90	10

Coffee beans were roasted in a roaster (ZF 94 Lab, Israel) at 218 ºC for Coffea Arabica (“Urban Roasting”) and 240 ºC for Coffea Canephora (“French Roasting”), then ground with a coffee grinder (SCODY II, Anfirm, Italy) to the required degree of grinding according to the technologies of coffee drinks preparation (Table 2).

Table 2

Dependence of the degree of coffee grinding on the method of coffee drink preparation

Method of the coffee drink preparation	Grinding time, s
Coffee machine	10–15
Cezva	20–25
French press	7–10
Aeropress	15–20

Coffee drinks were prepared taking into account the optimal ratios of coffee and water for classic and alternative brewing methods. Thus, for the preparation of espresso in a coffee machine 18 g of coffee per 40 ml of water were taken, while for other methods of brewing this ratio was 15 g of coffee per 250 ml of water.

Organoleptic evaluation of coffee drinks was performed by the method of conditional profiling according to GOST ISO 13299-2015. A group of 6 experts was assembled for sensory analysis. Samples encoded with three-digit numbers were tasted, assessing odor and taste by the descriptors of Coffee Taster's Flavor Wheel by SCA [8]. The obtained results were calculated by mathematical methods and used to build profilograms using MS Excel.

The active acidity of coffee drinks was measured by the potentiometric method using a pH meter, the total mineralization – by the refractometric method. The extraction level was calculated by the formula:

Extraction level (%) = Drink weight (g) x TDS (%) / Grinded coffee weight (g).

At the first stage of the research, sensory analysis of studied blends was performed. The smell and the taste of coffee drinks were described by the following descriptors: enzymatic, sugar browning and dry distillation aromas were distinguished for the smell; sour, sweet, salt and bitter components for the taste. Profilograms of coffee drinks are shown in Fig. 1.

As one can see from Fig. 1, the organoleptic characteristics of coffee drinks vary significantly depending on the blends quality. Thus, blend 1 (Fig. 1a) is characterized by a mixture of sugar browning aromas with aromas of dry distillation, as well as prevalent bitter and salty flavors, due to the significant content of caffeine and chlorogenic acid in the Coffea Canephora beans, which predominate in this blend. In the blend 2 the sensitivity of dry distillation aromas decreases significantly and there is a slight shift of the organoleptic profile curve towards an increase in enzymatic aromas (Fig. 1b).

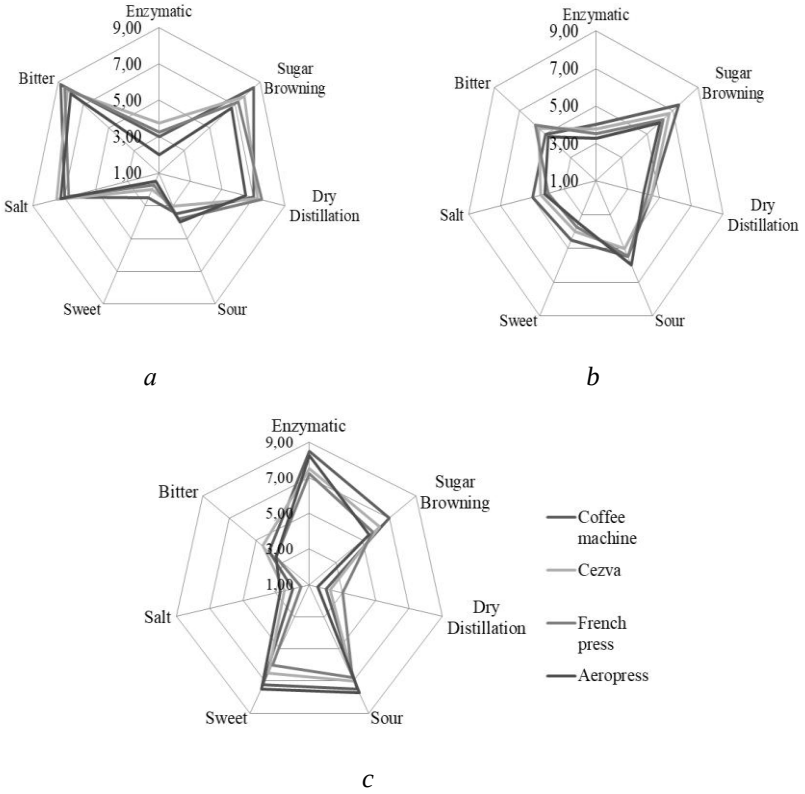

Fig. 1. Profilograms of coffee drinks for the blend 1 (*a*), blend 2 (*b*) and blend 3 (*c*)

Taste parameters are characterized by an increase in the sour and sweet components, which are fully revealed in the blend 3, as well as a significant decrease in the bitter and salty components. The aromatic profile of the blend 3 (Fig. 1c) harmoniously combines sugar browning and enzymatic aromas, and the taste is characterized by the absence of salty aftertaste and slight bitterness, which is overlaid with sour and sweet notes formed by higher content of sugars, lipids and esters, in particular ethyl burritate, in Coffea Arabica compared to Coffea Canephora [9].

The method of brewing also has an impact on the organoleptic profile formation. Thus, the prevalent sour and sweet notes are observed in the flavor of drinks prepared in the aeropress and coffee machine, while drinks made in cezve and French press are characterized by a lower

intensity of sweet and sour flavors. This is due to the fact that the increase in the content of complex organic acids and furans is directly proportional to the increase in water pressure flowing through the coffee during the preparation process [10].

It should also be noted that in the coffee preparation process the extraction is nonlinear: thus, firstly the organic acids and volatile aromatic compounds are transferring to the drink, the following are soluble carbohydrates and esters responsible for the sweetness of the drink, and the latest are sources of bitter flavor components – chlorogenic acid and caffeine [11]. In view of this, the shift of the aromatic profile curve towards dry distillation aromas and the formation of a more saturated texture of the drink prepared in a French press can be explained by the increase in the percentage of chlorogenic acid transferring during high-temperature diffusion, which is typical for the most of immersion brewing methods. The increase in the intensity of dry distillation aromas can also be explained by the presence of residues of oxidative deamination reactions, namely ammonia [12], which do not have time to pass to the drink because of the high speed of coffee preparation process when using coffee machine or aeropress, or completely evaporate during coffee preparation in a cezve.

At the second stage of study, the influence of the brewing method on the change of physicochemical properties of coffee drinks prepared on the basis of different blends was investigated. In particular, the change in active acidity (Fig. 2), TDS (Table 3) and the degree of extraction (Fig. 3) was studied.

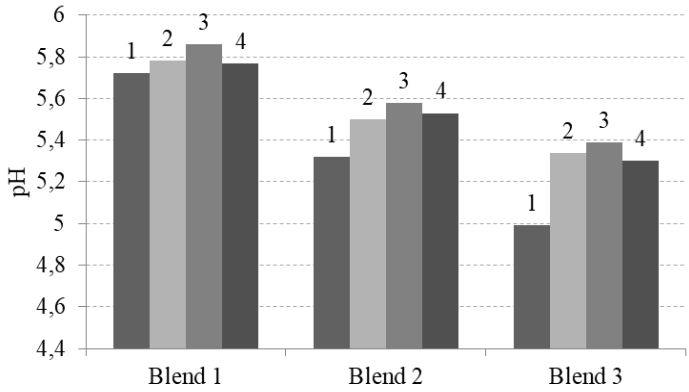

Fig. 2. Change in the active acidity of coffee drinks depending on the brewing method: 1 – using a coffee machine; 2 – in a cezve; 3 – in the French press; 4 – in the aeropress

According to the data shown in Fig. 2a, the active acidity of coffee drinks decreases with increasing of Coffea Arabica ratio in the experimental blends. This trend is determined by the significant content of organic acids that accumulate in Coffea Arabica beans due to their high density, formed because of oxygen lack at a significant height, where these types of coffee beans grow [13].

Regarding the effect of the coffee brewing methods on active acidity, it can be noted that the lowest is the pH of drinks made with a coffee machine and aeropress, due to the increased degree of organic acids transition, which is caused by the high pressure inherent in these methods of coffee brewing [10].

Table 3

Change in the TDS of coffee drinks depending on the brewing method

Name of the blend	TDS, %			
	Coffee machine	Cezve	French press	Aeropress
Blend 1	9,9	1,19	1,07	1,11
Blend 2	10,2	1,22	1,14	1,18
Blend 3	9,7	1,15	1,11	1,09

Analysis of TDS changes, given in table 3, indicates that the amount of dissolved solids in coffee drinks prepared in the coffee machine is significantly higher compared to the same indicator for drinks prepared by other methods. This otherness can be explained by the significant difference in the ratio of coffee and water used for brewing according to classical technology. Thus, for drinks prepared in a coffee machine, the ratio of coffee to water is 1:2.2, while for other methods of brewing this ratio is 1:16.7.

The change in TDS is also influenced by another technological factor, namely the grinding degree [14]. In particular, the smallest was the grinding of coffee used for brewing in a cezve, which correlates with the highest percentage of dissolved solids in the studied coffee drinks. Coarser was coffee grinding for aeropress, and the TDS of the corresponding drink is lower compared to the one brewed in a cezve. The coarsest grind was used to prepare coffee in the French press, which makes the corresponding TDS lower compared to analogous indicators.

Regarding the difference of TDS for coffee drinks prepared from different coffee blends, the main value in this case is the chemical composition of the beans, which varies significantly depending on the type of coffee [15]. Thus, blend 1 contains mainly Coffea Canephora beans, which are characterized by a high content of sodium, magnesium and

phosphorus salts, due to which coffee drinks made on the basis of this blend have a higher TDS compared to the blend 3. Coffea Arabica beans, which predominate in blend 3, are characterized by an increased content of calcium salts and sulfates, but the total content of other salts is much lower compared to Coffea Canephora beans, which explains the decrease in dissolved solids in the prepared drinks. As for drinks made on the basis of blend 2, they are characterized by a significant degree of transition of salts from beans of both varieties, due to which their TDS is the highest.

The extraction level was calculated based on the obtained TDS values. The results of the calculations are shown in Fig. 3.

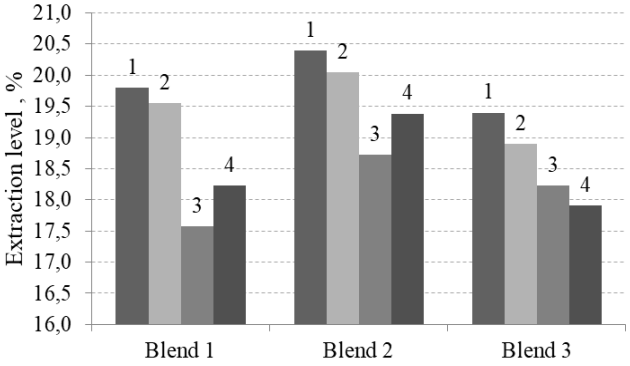

Fig. 3. Change in the extraction level of coffee drinks depending on the brewing method: 1 – using a coffee machine; 2 – in a cezve; 3 – in the French press; 4 – in the aeropress

According to the data shown in Fig. 3, the highest is the extraction level of coffee drinks prepared on the basis of blend 2. The extraction rate is the highest for beverages made with a coffee machine, slightly lower for beverages brewed in a cezve, lower for beverages brewed using an aeropress, and the lowest for beverages brewed in a French press. Given the above data, it should be noted that the dynamics of the extraction level correlates with the dynamics of changes in TDS and is explained by identical patterns.

Conclusion. Thus, a conducted complex study proved that the method of brewing and the ratio of different types of coffee beans in the blends have a significant impact on the organoleptic and physicochemical characteristics of coffee drinks. Thus, increasing the content of Coffea Canephora beans in coffee blends promotes the increase of pH, TDS and the extraction level of coffee drinks, but shifts the organoleptic profile towards bitter tastes and aromas of dry distillation. The presence of dry distillation

flavors for beverages prepared in the French press is stronger compared to analogues prepared in other ways, but the TDS and extraction level for such beverages are the lowest.

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DEVELOPMENT OF EXTRUDED PRODUCTS FROM STARCH-CONTAINING RAW MATERIALS WITH VEGETABLE ADDITIVES

O. Bunyak, S. Sots

Promising technology that provides a significant intensification of production processes is thermo-moisture-mechanical processing of starch-containing raw materials, carried out using extrusion techniques. Extrusion processing of starch and starch-containing raw materials allows you to get food that is completely ready to eat (snacks, breakfast cereals, cereals, etc.), instant food (semi-finished chips, puddings, drinks and jelly, soups do not require cooking). Corn contains four times more monounsaturated and 2–3 times more polyunsaturated fatty acids compared to wheat. During the production of flour, some of the fatty acids are lost. Investigated the grain of corn varieties "Dobrynya". A study of samples of the obtained extrudates based on corn grain was carried out. All indicators were determined using standard and original methods.

The developed compositions are realized in production conditions of the private enterprise. The developed products deserve due attention and are recommended for development of normative documentation on them.

Key words: *corn, grain processing, food products, breakfast cereals, grain mixtures.*

РОЗРОБКА ЕКСТРУДОВАНИХ ПРОДУКТІВ ІЗ КРОХМАЛЕВМІСНОЇ СИРОВИНИ З РОСЛИННИМИ ДОБАВКАМИ

О.В. Буняк, С.М. Соц

Перспективною технологією, що забезпечує істотну інтенсифікацію виробничих процесів, є термовологомеханічна обробка крохмалевмісної сировини, що проводиться з використанням екструзійної техніки. Екструзійна обробка крохмалю і крохмалевмісної сировини дозволяє