COFFEE, TEA, AND SPICES

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Summary

In a broad sense, the name coffee is used not only for fruits of the coffee tree (cherry coffee), but also for processed fruit such as green (raw) coffee, roasted coffee, instant coffee, and coffee as a beverage. The grading and quality evaluation of coffee beans is based on uniformity, purity, the absence of damaged beans, and decisively on the organoleptic properties of the beverage prepared from roasted beans (cup quality).

Generally speaking, teas can be divided into three classes: green teas, fermented black teas, and semifermented and oolong teas. Uniformity, purity, absence of foreign materials, and the characteristic flavor and taste of the beverage obtained from tea are the main factors in determining the quality.

Concerning different spices, it can be stated that, although in some cases the quantity of volatile oils—eventually the concentration of a characteristic component (e.g., vanilla-aldehyde, piperine in pepper)—may be a basis of quality evaluation, generally the flavor (odor and taste) is controlled organoleptically.

1. Introduction

Coffee and tea are not consumed for nutrition. Thus by evaluation of the quality of coffee, tea, and their products, their flavor, aroma and desirable physiological and psychological effects are most important. This means that sensory properties play the main role in quality determination. Chemical indices serve generally for detection of adulteration and confirmation of authenticity. It is the same situation in the case of spices. Only some of the more widely used of the many spices have been treated here.

2. Coffee and its Products

The use of coffee as a beverage dates back more than 700 years. The coffee tree is indigenous to Ethiopia. From there its propagation spread to Arabia in the seventeenth century, and then to India, Ceylon, and Java. Later it was introduced into South America, Indochina, and other parts of Africa. The beverage was taken from Arabia into Turkey, and later into Europe and North America.

The name coffee is used as a general term for the fruits and seeds of plants of the genus *Coffee.* This term also applies to processed coffee as beans, ground coffee extract, or instant coffee as coffee brew.

The ripe coffee fruit, cherry coffee, is the object of primary processing in coffee producing countries. In the so-called “dry process,” the coffee cherry is dried and the dried pericarp is removed by mechanical treatment. The wet process consists of mechanical removal of the exocarp in the presence of water, and removal of all the mesocarp by fermentation, washing, and drying. Both types of primary processing result in green coffee.

2.1 Green Coffee

Among factors influencing the quality of green coffee, the uniformity of bean size and shape, the presence of foreign matter, and color all are primary in importance. The green coffee bean has a characteristic shape. The flat bean has a perceptible flat face; if a single seed is developed in the fruit (instead of the normal two), the bean is nearly oval. Sometimes an assembly of more beans occurs (elephant beans). Among foreign matter not originating in the coffee cherry, stones, sticks, and soil particles are the most common. The presence of dried coffee cherries, husk fragments, endocarp (parchment) pieces, broken beans, beans with wrinkled surfaces (immature bean, quaker bean), and insect-infected beans (coffee beans harboring one or more live insects), coffee beans containing dead insects or moldy beans are signs of lower quality.

Blue to gray green is the most desirable color. Bleached-out pale white to grey colorations testify to poor storage or processing history. A non-uniform coloration of beans in the sample tray is a sure sign of non-uniform quality. Green coffee has a characteristic odor. Defective beans may have an unpleasant odor or sour taste.

The additional control of uniformity of green coffee may be realized by roasting small samples of green coffee and studying the appearance of the resulting sample.

The aromas given off during roasting usually reveal the quality of coffee. The ultimate criterion of coffee quality is cupping flavor. Briefly, the coffee flavor must be typical of the class it represents. There must be no off-flavors. The almost universally employed method of brewing in the green coffee trade is a simple steeping process. After roasting the green coffee in a small gas-fired or electric coffee roaster, and then grinding, 10 g of the ground coffee is placed in a small porcelain cup of 150 ml capacity, boiling water is added, and the cup and contents are allowed to stand for a few minutes. The grounds settle, and are allowed to rest in the bottom of the cup. A portion of the brew is "slurped" through the mouth, its flavor assessed, and then spat out (for test purposes).

2.2 Roasted Coffee

The greatest part of the coffee goes to the consumer as roasted coffee. Roasting of the green coffee is a heat treatment that produces fundamental chemical and physical changes in the structure and composition of green coffee, bringing about darkening of the coffee and development of the characteristic flavor.

Evaluating the quality of roasted coffee requires the control of the presence of foreign matter (mineral, animal, or vegetable matter not originating in the coffee cherry). Sticks and stones are the most common foreign matters found, along with husks, endocarp fragments, insect damaged beans, dried cherry coffee, and black or carbonized beans. The possible defects are similar to those of green coffee.

In the market, coffee is graded by number of imperfections, which may include black beans, broken beans, shells, immature beans, stones, sticks, and pods. Coffee with the lowest number of imperfections is of the highest quality.

Keeping in mind that roasted coffee is consumed as a beverage, it is understandable that in the evaluation of coffee quality, flavor plays the most important role. Flavor depends on many factors, including type of coffee, intensity of roasting, method of brewing, and so on.

In addition, roasted coffee changes in flavor a few days after grinding or after a package is opened. The dullness or flatness of flavor, eventually becoming staleness or even rancidity (if the coffee is kept for a long time), robs the coffee beverage of its pleasing effect on the sense organs of taste and smell. Loss of carbon dioxide and oxidation of unsaturated fats in the coffee are assumed to be the causes of the change in flavor. These changes are easily observed, at ordinary temperatures, by the fourth or fifth day, but if the dry coffee is kept at lower temperature the changes are less rapid. Thus, the correct preparation of coffee as a beverage requires that the beans be freshly roasted and ground.

Several hundred kinds of coffee are bought and sold worldwide. *Coffea arabica* and *Coffea robusta* are the two main species grown in the world, and their seeds are processed into commercial coffee products. The two main types are divided into groups according to place of growing, and into subgroups according to specific characteristics. For instance, Brazilian coffees are classified into four groups that bear the names of the ports through which they are exported: Santos, Rio, Victoria, and Bahia.

Because of the great variety of products and chemical complexity of flavor compounds, evaluation is subjective. Nevertheless, for each given type of coffee there is an expectation of required flavor qualities. Thus, for a wet-processed, arabica coffee (Colombian, Costa Rican, and so on), a "fine acidity with aromatics" and a "medium body" are looked for. Any occurrence of off-flavors causes downgrading. These off-flavors are noted in the flavor terminology as "oniony, woody, fermented, grassy, earthy, sour," and so on.

Dry processed arabica coffees (mainly Brazilian), on the other hand, are not expected to be so acid or aromatic, but to have "body" and to be within a defined range of harshness from "strictly soft" through to "hard," each associated with particular regions.

The degree of roasting markedly affects the level of acidity and bitterness; the darker the roast, the more bitter and less acid will be the resultant brew (from whatever coffee is used). It is well-known that while US, German, Swedish, and UK consumers tend to prefer light-medium and medium roasted coffee, the French, Italian, and Spanish prefer a darker roast, though the latter preference is perhaps associated with the marked use of robusta coffee.

Although the chemical composition of coffee beans is of special concern for the chemist and technologist, and a lot of data about gross chemical composition of green and roasted coffee has been published, the gross chemical composition does not play a significant role in quality evaluation. The general analysis of coffee, in which moisture, proteins or nitrogenous material, carbohydrates, fatty substances, caffeine, and mineral matter are determined, gives its approximate composition, and coffees from widely separated regions show no greater differences in these respects than could be ascribed to differences in soil, altitude, climate, and methods of agriculture.

The average gross chemical composition of green and roasted coffee may be characterized by the following data:

Ingredient	Green coffee (%)	Roasted coffee (%)
Moisture	8.5–9.5	3.0–4.2
Ash	3.9–4.0	4.2–4.7
Oil	12–14	13–14.5
Caffeine	1.2–1.8	1.0–1.4
Fiber	20–23	14–16
Protein	9–12	11–15
Water extract	30–32	30–34

The caffeine content of coffee is a quality index due to the fact that the physiological effect of coffee is dependent on the amount of this compound.

In connection with adulteration and safety of coffee, some other chemical determination may be needed from specific analytical procedures, for example, control of eventual

contamination with toxic heavy metals and presence of mycotoxins (primarily ochratoxins) as a result of attack by mold (see *Food Quality and Assurance*).

2.3 Processed Coffee Products

Decaffeinated coffee. The first commercial coffee decaffeination process was developed in Germany about the end of the nineteenth century and the beginning of the twentieth. The ability to extract caffeine with little or no effect on other components of coffee beans makes it possible to produce caffeine-free coffees which have considerable commercial importance. The procedure used for decaffeination does not remove any considerable part of the aroma compounds. Naturally the stimulating effect of caffeine is missing. Caffeine can be removed both from green and roasted coffee, but usually green coffee is decaffeinated and then roasted. Until World War II, caffeine-free beans were generally sold. Thereafter, soluble decaffeinated coffees came into prominence both in Europe and America.

Instant coffee. The production of coffee extracts (in the form of both concentrates and dry extracts) started at the beginning of the twentieth century. The most popular product, instant coffee, is a spray-dried coffee extract, which is water soluble. It should be obtained exclusively from roasted coffee by physical methods, using water as the only carrying agent that is not derived from coffee. Good water solubility and characteristic flavor are the main quality indices forming the basis of evaluation. The best of such products gives a fair substitute for freshly brewed coffee but never seems to reach the perfect flavor.

They are, however, generally much superior to ordinary coffee brewed from old or stale ground beans, or ruined by long boiling and the consequent woody flavors. Eventual adulteration of instant coffee with coffee husks/parchments, cereals, malt, maltodextrins, and caramelized sugar may be detected, based on free and total (after hydrolysis) carbohydrate profiles of soluble coffee. Pure, soluble coffee is characterized by low, free carbohydrate contents and high amounts of total galactose and total mannose.

Products adulterated with coffee husks or parchments present high levels of free mannitol, free fructose, total glucose, and total xylose. Products adulterated with starch-containing substitutes (cereals or malt), maltodextrins, or caramelized sugar exhibit high amounts of free fructose, free glucose, and sucrose, and huge levels of total glucose

Coffee substitutes. Products called coffee substitutes are roasted or melted grains and roots. Although the beverages prepared from these products have some similar characteristics to coffee, they do not contain caffeine or the corresponding stimulative effect, and their flavors are not as rich and characteristic as that of coffee. The most well-known is chicory and there are some cereal-based products. Coffee substitutes are frequently used as additives (fillers) in coffee blends. In botanical description and chemical composition, chicory has no relationship to coffee. When roasted and ground, it resembles coffee in appearance, but has an entirely different flavor.

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Biographical Sketch

Radomir Lásztity, D.Sc., Professor of Biochemistry and Food Technology at Budapest University of Technology and Economics, was born in 1929 in Deszk, Hungary. He completed his studies in 1951 at the Faculty of Chemical Engineering of the Technical University of Budapest. Dr. Lásztity received his M.Sc. degree in Chemical Engineering in 1951 and his D.Sc. degree in Chemical Science in 1968.

Dr. Lásztity is honorary president of ICC (International Association for Cereal Science and Technology). He was Chairman of the Codex Committee on Methods of Analysis and Sampling of the FAO/WHO Food Standard Program in the period 1975–1988. Dr. Lásztity is a member of the Food Division of the Federation of European Chemical Societies, and a member of the editorial boards of several international scientific journals. He was Vice-Rector of the Technical University from 1970 to 1976.

Among other awards, he has received the Bailey and Schweitzer Medal of the ICC, the State Prize of the Hungarian Republic, and the Golden Medal of the Czech Academy of Sciences.

Dr. Lásztity's main research activities are chemistry and biochemistry of food proteins, food analysis, and food control. The results of his research work have been published in more than 700 papers in foreign and Hungarian journals. He is the author of more than 20 books and textbooks (among them: *Chemistry of Cereal Proteins*, First and Second Editions in 1984 and 1996, respectively; *Amino Acid Composition and Biological Value of Cereal Proteins*, 1985; *Use of Yeast Biomass in Food Production*, 1991; *Gluten Proteins*, 1987; and *Cereal Chemistry*, 1999.)