



Determining caffeine content in different coffee types

Determinação do teor de cafeína em diferentes tipos de cafés

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Abstract

The aim of the current study is to evaluate caffeine contents in different coffee brands and types by analyzing, determining and comparing their values, by checking their compliance with the legislation, and by indicating whether the processing type may influence caffeine content. The method encompassing extraction, separation, purification and gravimetric determination was herein adopted to help setting the caffeine contents in different coffee samples. These samples comprised three soluble coffee (Cs1, Cs2, Cs3), three coffee powder (Cp1, Cp2, Cp3) and three coffee bean brands (Cb1, Cb2, Cb3), which were subjected to content analysis. According to CNNPA Resolution n. 12/1978, coffee samples should present at least 0.7% caffeine per 100 grams of product. The herein analyzed samples recorded the following results: Cs1 (0.36%), Cs2 (0.54%), Cs3 (0.56%); Cp1 (0.36%), Cp2 (0.39%), Cp3 (0.42%); Cb1 (0.48%), Cb2 (0.46%) and Cb3 (0.46%). The analysis applied to help determining the caffeine content in different coffee types showed that these contents changed depending on how the samples were presented (beans, powder and soluble). Results evidenced that the soluble coffee presented higher caffeine content than coffee beans, which were followed by coffee powder.

Keywords: Beverages. Coffee. Caffeine. Identity and Quality Standard for Products and Services.

Resumo

Buscou-se avaliar os teores de cafeína em diferentes marcas e tipos de cafés, analisando, determinando e comparando seus valores, verificando a conformidade com a legislação, e apontando se o tipo de processamento pode influenciar neste teor. Para a determinação de cafeína em cafés, adotou-se o método que envolve extração, separação, purificação e determinação por gravimetria. Para o referido estudo as amostras foram compostas por três marcas de café solúveis (Cs1, Cs2, Cs3), três marcas de cafés em pó (Cp1, Cp2, Cp3) e três marcas de cafés em grãos (Cg1, Cg2, Cg3) para análise dos teores adquiridos. De acordo com a Resolução CNNPA nº12/1978, os cafés devem conter pelo menos 0,7% de cafeína em 100 gramas do produto. Foram encontradas, Cs1 0,36%, Cs2 0,54%, Cs3 0,56%; Cp1 0,36%, Cp2 0,39%, Cp3 0,42%; Cg1 0,48%, Cg2 0,46%, Cg3 0,46%. Através das análises da determinação de cafeína nos diferentes tipos de cafés consumidos, foi possível observar que os teores variam em função da forma em que eles se apresentam (grão, pó e solúvel), sendo que a forma em café solúvel apresentou uma maior quantidade de cafeína do que o em grãos, seguido pelo em pó.

Palavras-chave: Bebidas. Café. Cafeína; Padrão de Identidade e Qualidade para Produtos e Serviços.

Introduction

Coffee is a noble agribusiness product, which is part of the Brazilian export agenda, since it has prominent place in the country's development history. Its taste and aroma provide great receptivity to coffee-based products consumed worldwide. The coffee industry has been adopting new techniques, besides the already consolidated sensorial analysis techniques, to analyze its products. They aim at pursuing innovations capable of meeting the expectations of European and North American markets.¹

Nowadays, coffee is the most consumed beverage in the world. Its consumption has been constantly increasing because it presents substances that speed up human metabolism.² The product is used in human diets to improve the performance of athletes and physical activity practitioners.

Coffee consumed in moderate amounts - up to four cups a day, on average - makes the brain more sharp and capable of performing intellectual activities; it decreases the incidence of apathy and depression, besides stimulating memory, attention and concentration. Therefore, coffee improves intellectual activity and is suitable for all ages, including childhood and adolescence.³

Coffee has more than 800 compounds belonging to several identified classes. Some of them are often mentioned in the literature, because they are associated with human health. Among them, one finds caffeine, which elevates the blood pressure; diterpenes, such as cafestol and kahweol, which may lead to metabolic disorders like dyslipidemias; and chlorogenic acids, which protect from atheromatous plaque formation.⁴

Caffeine is a chemical compound (formula $C_8H_{10}N_4O_2$) classified as alkaloid belonging to the xanthine group; it is also chemically designated as 1,3,7-trimethylxanthine. This compound is found in certain plants, besides being consumed as stimulant - in its infusion form - in beverages.⁵ Caffeine is one of the most known substances in coffee; it presents high antioxidant activity due to its metabolic effects. Such antioxidant activity results from 1-methyluronic acid and from 1-methylxanthine, which prevent LDL oxidation, since they act on lipid peroxidation, and such property is attributed to polyphenols resulting from 1-methyluronic acid and 1-methylxanthine metabolism.⁶

Several studies have investigated the relation between coffee consumption and the risk of developing cardiovascular diseases. This subject is the object of continuous discussions, since some studies found its increased risk for the development of cardiovascular diseases whereas others showed its reduced risk of it. However, evidences show that coffee may increase the risk of developing cardiovascular diseases when it is highly consumed, mainly due to the acute effect of caffeine.⁷

Given the importance of body reactions triggered by caffeine, it is worth questioning: What are the caffeine levels found in different coffee types and brands available in the market? Do such levels comply with the legislation?

It can be assumed that the caffeine content oscillation in different coffee types would result from its processing, from the addition of additives other than coffee, as well as from bean species and cultivation form. Coffee brands derive from different plantations and crop management procedures; thus, they can lead to different caffeine levels in the coffee. It is known that caffeine generates several health benefits when it is ingested in correct doses. Accordingly, like any other chemical, coffee overdose can lead to physiological disorders and dysfunctions.

In addition, inappropriate caffeine levels in human diets may lead to negative effects on people's routine, mainly in athletes' routine. The alertness enabled by caffeine reduces the resting metabolic rate necessary for the body to anabolize. Effects may be even stronger in the long term, fact that reinforces the need to assess in-depth the caffeine levels in different coffee types, since coffee is one of the most consumed beverages in the world.

In light of the foregoing, the aim of the current study was to evaluate the caffeine content in different coffee brands and types by analyzing, determining and comparing their values, by checking their compliance with the legislation and by indicating whether processing procedures may influence caffeine content.

Methodology

The present research is an experimental, quantitative and comparative study conducted with different coffee types and brands. The study was carried out in May 2017, in the chemistry laboratory of Juazeiro do Norte College, Juazeiro do Norte County, Southern Ceará State countryside, in the central area of Cariri Metropolitan Region.

The method by Foguel; Calderini & Aristaque⁸ was herein adopted to evaluate the caffeine content. The method of choice was of the random type. Samples were purchased at local supermarkets and online; they were sent to the laboratory and prepared for analysis. Three coffee brands were evaluated for each presentation form (soluble, powder and beans) in 250 and 500g packages, namely: soluble coffee 1 (Cs1); soluble coffee 2 (Cs2); soluble coffee 3 (Cs3); coffee powder 1 (Cp1); coffee powder 2 (Cp2); coffee powder 3 (Cp3); coffee beans 1 (Cb1); coffee beans 2 (Cb2); coffee beans 3 (Cb3), thus making a total of 9 samples analyzed in triplicate (27 experiments, in total).

The following steps were taken to evaluate the caffeine content: caffeine extraction through sulfuric acid; purification through chloroform and characterization through isopropanol and hexane. The caffeine amount in the herein evaluated different coffee types was measured through gravimetry.

Data were tabulated in *Microsoft Office Excel 2010* worksheet in order to generate tables and graphs; simple standard deviation at 5% significance level was used to define the results through mean values.

A study comparing the different coffee presentation forms (beans, powder and soluble) was carried out in order to check whether processing procedures influenced the caffeine content. In addition, values found in the aforementioned study were compared to data recorded in the literature and analyzed by taking as reference the values allowed by the legislation.

Results

Results showed that soluble coffee was the one recording the highest mean caffeine rate in comparison to coffee beans and powder (**Table 1**).

Table 1. Caffeine content in different coffee brands and types analyzed in triplicate. Juazeiro do Norte County, CE. 2017.

Variable	n	Mean (%)	Standard Deviation
Soluble coffee	3	0.486	0.110
Coffee powder	3	0.390	0.030
Coffee beans	3	0.466	0.011

n= number of brands analyzed for each coffee type.

It is noteworthy that the herein evaluated coffee types presented different caffeine content variations. Soluble coffee recorded the highest caffeine content variation (0.36% - 0.56%) among the analyzed brands, whereas coffee beans recorded the lowest one (0.46% - 0.48%).

Discussion

Lack of information about the amount of caffeine in coffee labels makes it difficult to adjust human diets, since consumers' health can be exposed to negative effects of caffeine, such as the psychoactive ones. These effects can lead to physiological dysfunctions in the human body when people consume too much caffeine.

One of the explanations for such lack of information in coffee labels could be related to blends with several species without proper quantity determination, since caffeine content can change from species to species. Moreover, there is lack of standards forcing coffee industries to present information about caffeine content, since the National Health Surveillance Agency (ANVISA - Agência Nacional de Vigilância Sanitária) only sets the minimum caffeine content for the product.

Based on our results, none of the herein analyzed coffee brands was in compliance with the National Commission on Food Standards and Norms N. 12/1978 (CNNPA - Comissão Nacional de Normas e Padrões para Alimentos). These norms state that the powdered product should have at least 0.7% caffeine per 100 grams of coffee; contents found in the present study were lower than the recommended ones.⁹

Each coffee type was individually analyzed to compare the caffeine content in different brands. Results showed significant quantitative variation between the analyzed brands possibly due to pre-consumption processes, or even to different planting and harvesting processes.

Accordingly, Nogueira & Trugo⁴ found that coffee composition changes depending on the processing conditions, as well as on the species and varieties used in blends made by manufacturers,

since caffeine content can vary even in coffee powder from a single manufacturer. According to the aforementioned authors, coffee belonging to species *Robusta* presents higher caffeine and chlorogenic acid levels and lower trigonelline levels than coffee belonging to species *Arabica*. Thus, the participation of each species in manufacturers' blends, and the processing conditions, determine the final coffee composition.

There was small variation between different coffee types: soluble coffee presented higher caffeine content than the other types; it was followed by coffee beans and coffee powder.

Caffeine content in raw beans from different lines can change depending on crop location, on the genetic origin of the coffee and on harvesting time because of differences in the ripening stage of coffee fruits.¹⁰

Differences in caffeine level between powder and instant coffee types may result from the bean variety used in the formulations. Caffeine content in the seeds of *Robusta* species is higher than the one recorded in seeds of *Arabica* species. According to Jacobs, Pasternak & Bell,¹¹ the *Robusta* species is often used to manufacture instant coffee, whereas the *Arabica* one is used to produce roasted coffee powder.

The relation between caffeine consumption and the possible development of some diseases has long called scientists' attention. Although there is no evidence that caffeine intake at moderate doses (~300 mg / day) is harmful to the health of normal individuals, this substance has been continuously studied, since many doubts and controversies about its adverse effects on human health remain.¹² However, its intake in large doses leads to excitability, anxiety and insomnia. Yet, habitual consumers develop a certain tolerance to the effects of this compound, since they gradually increase its intake in order to reproduce the initial effects.¹³

Caffeine has been used as research instrument in several studies focused on increasing individuals' physical performance in different sports modalities and practices.

Some studies showed that caffeine supplementation did not improve maximal muscle strength performance, whereas others have reported improved performance after caffeine intake, which was enough to make caffeine supplementation widely spread in the sports environment.¹⁴⁻¹⁶ Studies showed that caffeine can improve the physical performance in several aerobic exercises such as running,¹⁷ cycling,^{18,19} rowing²⁰ and even soccer.²¹

The ergogenic effect of caffeine on muscle strength-training performance has not yet been fully established, nor have the mechanisms triggering physiological actions on the human body.¹⁴ On the other hand, our results were corroborated by other authors, who found improved muscle strength performance in individuals subjected to caffeine intake.¹⁶

The sports field has developed many studies about caffeine use and found controversial results.¹³

Conclusion

The current results showed caffeine content variation between the tested coffee types. Soluble coffee (0.486%) presented higher caffeine level than coffee beans (0.466%), which were followed by coffee powder (0.360%). Thus, it is possible stating that caffeine amounts in different preparations change depending on presentation form (beans, powder and soluble), on the amount used, as well as on species/variety/blend and coffee cultivation type.

Collaborators

Benjamim CJR and Rocha EMB helped interpreting data, revised the article and approved the definitive version; Carvalho LB participated in data collection; Mori E and Silva CJRS participated in data collection and in the study writing.

Conflict of interests: The authors declare no conflict of interests.

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