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Biotechnology in the production of beverages: the teaching of chemistry from the production of aguardente de cagaita (Eugenia dysenterica)

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The diversity in the types of vegetation, Brazil is the second largest biome Cerrado, occupying 25% of the country, surpassed only by the Amazon. In Minas Gerais, the Brazilian state has about 10.3% of its area the Cerrado vegetation, covering mainly areas of the Upper and Middle Jequitinhonha. The flora of the cerrado has several fruit species with high potential for agricultural use, which are traditionally used by local people, and the fruits have high levels of sugars, proteins and minerals. Among the great diversity of plants and fruits present in the cerrado is the Eugenia dysenterica, popularly known as cagaita. The fruit is globular yellow color when ripe, slightly acid and can reach up to 4 cm long and up to 5 cm diameter. The work here exposed was led initially to a survey of state schools that have high school in the city of Sete Lagoas-MG. After this survey was chosen for the project development a nearby school of the Federal University of Sao Joao del Rei (UFSJ-CSL) for viability of the project and in which direction proved to be very available. 3rd year high school classes were chosen, totaling 55 students, selecting the students who had greater knowledge of the concepts studied and shown interest. Various activities with students have been developed, one of which is the application of a questionnaire in the first meeting, which enabled us to identify where the problems thereof. a booklet with texts followed fixation exercises and illustrative images on each topic worked in class and the students images developing the proposed project activities was developed. This study aimed to use a fruit of the Cerrado, cagaita to perform fermentation and subsequent distillation, to promote ownership of the concepts of chemistry, biochemistry and biotechnology in high school students. Through the questionnaire at the end of the project, it was possible to assess the relevance of their work and the impact on the training of students. The study proved to be very promising for the students and the school, where probably, future students of the University. It is important to emphasize that the development of the project was very promising because it allowed greater interaction of students with dynamic classes, practical and contextualized, allowing a greater learning of them.
Keywords: cagaita, biotechnology, Eugenia dysenterica, chemistry, education, Cerrado, brandy.

Introduction

Brazil has a diversity in relation to the types of vegetation having as second largest biome the Cerrado, which occupies about 25% of the national territory, being surpassed only by the Amazon (KLINK, 2005).

In Minas Gerais, the Cerrado Biome, according to the State Forest Institute (1996), has about 311,987.38 ha², which are equivalent to 10.3% of the original area which was of 30.8 million ha²(FERRI, 1975). It covers a part of the areas of Alto and Médio of the Jequitinhonha River, Alto and Médio San Francisco, Campo das Vertentes, Metallurgical Zone, Triângulo Mineiro and Alto Paranaíba (Brandão, 2000).

Data show the great deficiency that the Cerrado present because of the chemical composition of their soils. This is due to the effects caused by natural fires, and also to burn caused by man these soils have acquired a tolerance (SANO et al., 1998).

Even with implications on the growth and development of plants by the lack of rain and the peculiarities of the soil, the Cerrado has a high diversity of species. It is, in this region, more than 40 types of physiognomic landscape, among these, the Cerrado, the Cerradão, the campo limpo, the savanna, the path, the gallery forests and the limestone forest. This biome, still little studied, presents great potential food, timber, agribusiness,

medicinal and ornamental plants (AVIDOS, 2000). Although it is apparently dry and arid, he surprises with variety in its flora and mainly on flora (SANO et al., 1998). The flora of the Cerrado has several fruit species with high potential for agricultural use, which are traditionally used by the local population, being that the fruits have high levels of sugars, proteins and mineral salts (COSTA, 2004).

The multiple species of fruit from the Cerrado have a high nutritional value and also of sensory parameters which include features like aromas, colors and intense flavors (MORAES et al., 2006). The consumption of fruits native to the Cerrado, a long time ago, already enshrined by the indians, was very important to the survival of the first inhabitants of this region. Due to the adaptation and the quest for developing handling techniques and manipulation these fruits for survival, the man developed true culinary treasures, such as liquor, jams, jellies, porridges, cakes, juices, ice creams and snacks. The interest in these fruits has resulted in several studies in society, since small farmers, industries, housewives, traders and even research institutions and technical assistance (AVIDOS, 2000).

Among the wide variety of plants and fruits in this biome, one may find the Eugenia dysenterica, pertaining to the family of Myrtaceaes. It is popularly known as cagaita. The tree (figure 1) of this fruit receives the name of cagaiteira and presents the crooked trunk that can reach up to 10 meters in height, thick bark and cracked. The fruit, the cagaita, is a fruit globuliform of yellow when ripe, slightly acidic and may reach up to 4 cm in length and up to 5 cm in diameter.

Figure 1: Adult cagaiteira (Photo: Figueirópolis, TO, 2007, Maria Elisa Soares de Oliveira)

The fruit (figure 2) of cagaiteira can be consumed in natura or processed also for the fabrication of ice creams, manufacturing jellies and different types of beverages like juices and liquors. The Cagaita, when ingested, after going through the process of fermentation due to the sun incidence, cause effect laxative, must be controlled by eating a tea made from the bark or leaves of cagaiteira (BRANDÃO and FERREIRA, 1991).

The food market has grown increasingly, mainly in the area of alcoholic and non-alcoholic beverages. In production of beverages, have been used immobilized cells, which besides being low cost, are important for stabilization of cells and also in the increase of continuous processes of fermentation. (MARGARITIS, 1984).

Figure 2: Fuited cagaita. (Photo: Figueirópolis, TO, 2007, Maria Elisa soares de Oliveira)

Many publications of studies have showed the use of bioprocess (SOUZA, 2013), (CHAUD, 2009), making it clear that this technique is of utmost importance for both the economic viability and the achievement of animal by-products. Therefore, this type of technology, along with various plants found in the cerrado, can influence the conservation of these species (OLIVEIRA et al., 2010).

With the large amount of fruits highly rich in sugar present in the cerrado, the fermentation becomes viable for having a greater use and storage of these fruits.

In the processes of fermentation are involved various chemical and biotechnological reactions, since the insertion of enzymes that speed up chemical processes, until the transformation of the sugars present. The great biological and genetic diversity is the basis for that occur advances in the area of biotechnology and consequently in the processes of fermentation to obtain drinks. Requiring that food goes through simple chemical transformations.

In this way, the work may induce the students to reflect on the theoretical knowledge learned in the classroom and associates them to his empirical knowledge and everyday life. In this case, was explored the cerrado biome and related environments that surround it, which were fundamental to the awareness and, consequently, for the success of conservation programs that will be applied later.

Therefore, it started from a search for ways to preserve native fruit of Brazil, especially areas of cerrado, and also aware the local population that there are many plants that can be consumed by them or traded, generating a profit. The aim of this project was to illustrate, improve and educate

students in secondary education, employing the biotechnological process of fermentation of cagaitas and various subjects worked with them, promoting the appropriation of concepts in chemistry, biochemistry and biotechnology.

Methods

For the execution of the work, was chosen, from two classes of 3° year of high school from one of the public schools in the city of Sete Lagoas, Minas Gerais, a total of 65 students. This school is located next to the Federal University of São João del Rei - *Campus Sete Lagoas*, where the inserted students in the project attend graduation. Some criteria were followed to the viability and development of the work, among them: the proximity, easy locomotion, accession to the entire faculty and direction. After evaluated these parameters, the State High School Eponina Soares Santos was chosen to submit proposals for the project. Some regular meetings were held with the scholarship, mentor and some collaborators.

The following activities were selected to be worked with the pupils of the school: practices to be developed and prepare a handout with the theoretical concepts to be worked on**.** A questionnaire, at the beginning of the project and one at the end, was applied to the students to analyze their difficulties in the beginning and after the development of the project. After the first questionnaire, were addressed the following topics listed in the board below, being interspersed with practical activities and dynamics:

Table 1: Activities to be developed during the project

Cerrado: overview
Animal and vegetagion diversity
Ecological relations of cerrado
Human activity impacts on cerrado
Fruits of cerrado
Some tipical fruits of cerrado
Chemistry of fruits of cerrado
Cagaita
History of fermentation
Beverages fermented alcoholic biotechnology
Chemical control in the fermentation of drinks
Cagaita's fermented most by saccharomyces cerevisiae yeast
Distillation process
Distilled and baking-distiled baverages
Flavor and aroma of destilled drinks

For the realization of practical activities, have been prepared experiments to establish the context of the concepts discussed in table 1, for which provides students with a greater fixation and also interactive activities to awaken on them even more interest in the project.

As a way of not letting the students dispersed throughout the project, a methodology in which they developed small dynamics between activities was implemented.

For the experimental part was given to the students, in addition to the guidelines, an experimental script for them to follow and learn, contained in the prepared handout. The students prepared the wort to be fermented, by following the guidelines, and the system in which the fermentation process lasted seven days.

For the closure of the works, we applied the same initial questionnaire with the addition of some questions.

Results and discussion

The first contact with the direction of the State High School Eponina Soares dos Santos happened in a satisfactory manner in which the receptivity of the direction of the school was great. Also, a face-to-face meeting was marked which the scholarship holder and his advisor gave to the director, the vice-principals, and supervisors and also for some teachers, the work plan that would be developed. Everybody was very interested and accepted some suggestions including timetables.

As a way of checking the difficulties of the students, in stages, since the biome of fruit that passed through the fermentation process, until the chemical processes involved, a questionnaire was applied with 10 questions. With the results of the questionnaire, it was possible to note that students did not have much knowledge about the cerrado region. This was noticed in one of the questions that asked them to quote some types of fruits of the cerrado. The majority who had answered that they knew the cerrado replied names of fruits that are not part of the flora of the cerrado, noting that really had no knowledge.

To illustrate, here are, in Figure 3, the responses provided by students to the questions applied. There is a clear indication that students did not have basic knowledge such as, for example, the definition of the cerrado. In question 1, there was a balance in the answers but still with the answer that they did not know what is the cerrado biome. In the questions 2 and 3, though, the responses were extremely contradictory in relation to question 1, once the majority responded that they had already eaten a fruit of cerrado and also that this biome has economic potential and medicinal, with approximately 45% said they were not aware of the biome. Other interesting information observed, on this questionnaire, was about the fruits of the cerrado. Many students did not know how to differentiate the fruits of the cerrado and fruits such as banana, apple and guava, among others.

After listing all the results of the questionnaire, began the theoretical activities to enhance and broaden the students' knowledge of, because the teachings passed on they were passed on to others and to the community.

A booklet was developed with texts followed by exercises and illustrative images on each theme worked in class and images of students developing the activities proposed by the project, as the figure 4. In the booklet, still had all the experimental procedure developed for the

production of fermented drink of cagaita. It was delivered at the last meeting and some copies were filed in the school library

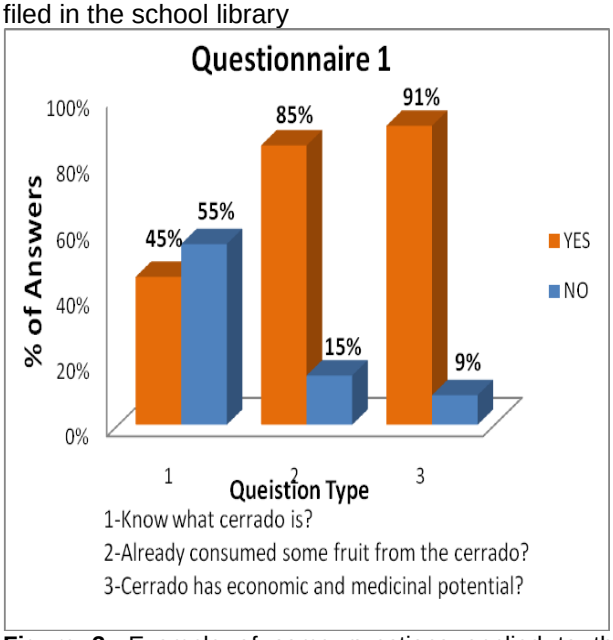

Figure 3: Example of some questions applied to the students of high school in the begging of the project.

Considering the results obtained, it was necessary to show them concepts about what really is the cerrado biome. To work with this concept, 3 meetings were separated to explain a little about the history of the formation of the cerrados, existing types and the Brazilian regions that have cerrado. It was, then, worked, still on the basis of the cerrados, flora, illustrating in a simple way, the great diversity of plants in this great biome and what were its characteristics.

Before joining the class on fauna in the cerrado, students were taken to the first visit to the laboratory, just to have the knowledge of the space in which they would use to perform the fermentation process.

Afterwards, the students were taken to the class to an activity in the form of debates on the fauna of the cerrado biome, so that the students answered some questions that were discussed and, then, gather more content passed to them. At the end of this meeting, has yet been proposed the issue of ecological relationships among animals, regions where the cerrado is predominant, inter-relating the importance on relations between human beings, and, especially, the cerrado, with causes and consequences of the relationship, which was a theme of one of the dynamics developed.

The realization of this dynamic aimed to reaffirm the importance of relations between humans and the team work, therefore, for the activities in the lab to occur in a satisfactory way, it was necessary the union and collaboration for an excellent activity of those moments later. Due to any error in the lab by handling equipment or by conflicts between the handlers, the experiment and the life of the members is put at risk.

The dynamics consisted of a circle among the students hand in hand, leaving a vacant space in the center. Then the scholarship holder put a roll of string in the center and requested a random student to pick up the string and speak to his colleagues his name, age and the discipline he most like and the least like, in summary and simple, just for everyone to know each other well, figure 4.

Figure 4: Dynamic web of string.

The dynamic was very important, because demonstrated that there always must be a person to give an initial step, as did the first student. Then, the string was cut, demonstrating that there will always be problems, but it is necessary to stop and change the form of act of the whole group.

The students, at all time, wanted in any way go to the lab perform the fermentation process. Some topic were worked as: the chemical compounds present in the fruits of the Cerrado, the processes involved in the production of beverages and also another key element in the project, about the stories and how the fermentation process is done, especially in the area of drinks, involving some biotechnological concepts.

Considering the delay on the fruiting of cagaiteiras of Sete Lagoas, it was not possible to lead students to collect the fruits that would be fermented, one of the initial goals proposed for having the opportunity to meet and have contact with the tree. So, the fruits that have gone through the process of fermentation are fruits stored at the university, collected during the previous year, 2014.

After performing the steps for the processes of fermentation of the wort of cagaita, students were taken to the Laboratory of General Chemistry School of the Federal University of São João Del Rei-(UFSJ-CSL), very important moment for the students, due to direct contact with a large and structured laboratory. It is important to emphasize that all students were very well oriented not to, at any time, taste or put hands on reagents. All the steps were very well monitored so that there would be no problems, because it was being prepared a fermented drink.

With the implementation of the last questionnaire, figure 5, it was possible to evaluate the relevance of the project and what is the impact on the formation of the students.

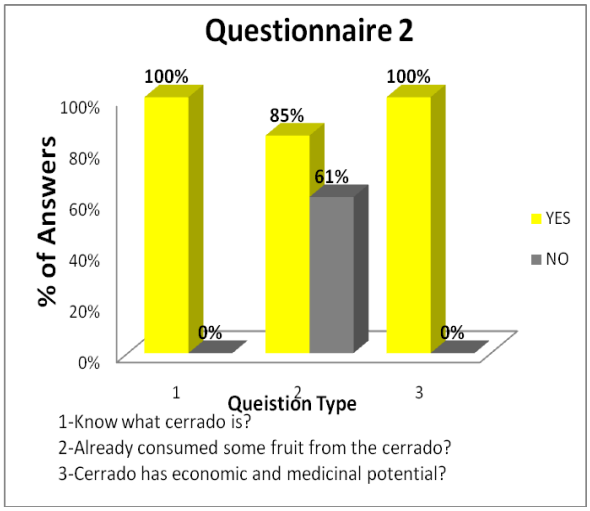

Figure 5: Examples of some of the issues applied to students of two classes of year 3rd at the end of the project.

In the questionnaire 2, were added a few questions to assess the level of satisfaction of students according to the development of the project. Through one of these issues, it was possible to plot a graph that brings the results that the project was, for the majority of students, satisfactory, and may contribute to their knowledge, figure 6.

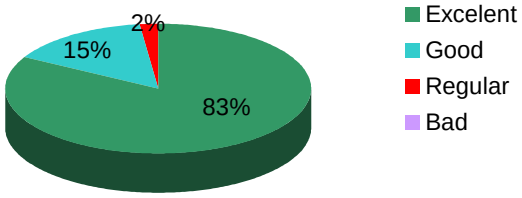

Figure 6: Result of the project evaluation done by the students.

Conclusions

Based on the data presented, the realization of this project had a positive effect, both by the school involved, so as by the part of students involved, putting into operation a laboratory that already exists at school but that was not in activity. This has resulted in a new place of learning. The project sparked interest in other teachers of the school in using the space of the lab as a way to fix the precepts past in the classroom, very positive impact, because the students were well more participative.

Although students were developing another project conducted by students of the University, this moment was one of the only ones in which students were able to relate the concepts past in the classroom with the practical part and experienced by them in their routine, for example, the ecological relationships.

It is important to emphasize that the development of the project was very promising as the students went out of the routine of the school year, with different lessons, exploring a small part of the world of science practice and learning from these meetings. Also learning about the importance of the region in which they live and that, not only for them and their families, but also for the fauna and flora. This region t is very important for people who do not live in these regions that may be consuming fruits or even medicinal plants even though they are far away from the local trade.

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