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Presentation

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Content

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The wild tomato (*Solanum lycopersicum* var. *cerasiforme*) of western Mexico, an alternative food, nutritional, and socio-economic

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Abstract

Mexico has wide genetic variability of tomato (*Solanum lycopersicum* L.), resulted from a long processes of domestication and diversification. Currently is one of the most important crops relating to marketing and use. However it is considered to *Solanum lycopersicum* var. *cerasiforme* wild ancestor of cultivated tomato, there is little information of this species, although it has recently highlighted its productive and ecological importance. Currently different investigations are aimed at assessing the benefit in their consumption due to its chemical composition, which provides a number of nutritional components such as carotenoids, vitamins A and C, sugars, minerals and antioxidants. This research was conducted to meet its quality physical, chemical, food, and nutritional. Collected seeds from wild plants of Jalisco, Colima, Michoacán and Nayarit; were planting in greenhouse at the University of Guadalajara; fruits produced were subjected to physical and chemical analysis in the laboratory. According to statistical analysis, there were significant differences in size and chemical composition, between populations and between different production cycles. The results in this study allow a better selection of these populations to be preserved in germplasm Bank at UDG, also contributes to promote its cultivation and human consumption.

Antioxidants, Citric acid, degrees Brix, tritatable acidity

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Introduction

Tomato, originally from the Andean region shared by Ecuador, Peru, Bolivia, and Chile (Rick, 1976), seems to have been domesticated by pre-Columbian peoples in Mexico and / or Peru where their two natural diversity centers Et al., 1990). The most probable ancestor of the cultivated tomato is the wild tomato Lycopersicon esculentum var. Cerasiforme (Esquinas-Alcázar and Nuez, 1995). In the Mexican biocultural ethnohistory there is evidence of a clear differentiation between green tomato and tomato, called in Nahuatl as miltomatl and xitomatl. To the tomato S. lycopersicum var. Cerasiforme is known in Jalisco, Nayarit and Colima as deer eye, jaltomate, Chaltomate or Tomatillo and in Michoacán as Tinguaraque (Rodríguez et al., 2009).

Tomato is a crop distributed around the world and occupies the second place worldwide, due to the nutritional value that it possesses, since it can be consumed cooked or raw; As well as having generated an entire industry that has activated the economy of many countries. In our country it is primarily a product for export, job creation and is one of the crops with the greatest use of technology and inputs. In the agro-industrial context, the last decade has been an expansionary period for the export sector of fresh tomatoes, market rules and production techniques are constantly evolving and therefore it is important to adapt to these conditions.

An example of this is the European markets which evolve towards a higher quality, forcing a constant improvement in order to successfully compete in the different markets that are increasingly selective and demand better quality attributes. The quality criteria considered by:

A) Buyer: Aroma, Texture, Taste, Size and Color

B) For Commercialization and Exportation it is required: Tomatoes: Healthy, Fresh, Clean, Dry, Mature, Firm and Well-formed

C) Consumer chooses: Color, Shape, Size, Consistency, Maturity and Presentation

Despite the importance of this fruit, we do not have much information about its properties growing in the wild, so we present data on the variation in size and chemical composition of tomato in wild populations of Solanum lycopersicum Var. Cerasiforme, that are developed in the West of Mexico, emphasizing its nutritional, alimentary, medicinal, socioeconomic and ecological importance.

Objetive: To determine whether wild tomato represents a nutritional, nutritional, and socioeconomic alternative for the inhabitants and wild fauna that live in areas where wild populations of tomatoes develop Solanum lycopersicum var. Cerasiform.

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Materials and Methods

Fruit pick.- Wild plants and native tomato varieties were collected during the years 2002 to 2006 and 2010 to 2012, in different regions of the West, using random sampling. Ten plants were randomly selected by locality and ten mature fruits of each one were taken, to which the seed was extracted, by means of liquefaction.

The seeds decanted at the bottom of the blender vessel were placed in weathering paper for drying for 24-48 h, seeds having good conditions were placed in a previously identified glass vial and stored in a refrigerator at a temperature of about 10 ° C.

Cultivation of the tomato.- Later the seeds were planted in the greenhouses located in the University Center of Biological and Agricultural Sciences of the University of Guadalajara during the cycles of spring-summer agricultural cultivation. The sample size was 30 plants.

Analysis.- The fruits collected from the greenhouse were taken to the laboratory where they were carried out a physical analysis and a chemical analysis.

Physical analysis of the fruit.- The weight (g) was determined with a scale with decimos of grams. Subsequently, the polar and equatorial diameter (mm) of each fruit was measured using a vernier.

Chemical analysis.- The fruits were split in half and separated from the peel, gently rubbing it in a colander collecting the pulp in a container, and the seeds were washed and dried at room temperature.

The pulp was determined: Total soluble solids (Brix degrees), citric acid (AT) and pH.

The seed was determined: Ash; Crude Protein; Crude Fat; Crude Fiber; Humid Matter; Dry material; Lignin; Calcium and Phosphorus.

Statistical analyzes were carried out using the statistical package SPSS® version 19 and SAS version 8.1. The data were evaluated for normality using the Kolmogorov - Smirnov test and for homogeneity of variances using the Levene Dytham test. The parameters of fresh weight, equatorial and polar diameter as well as ° Brix, pH and citric acid were compared between populations per year using a one-way ANOVA. Data from all harvests were analyzed using a two-way ANOVA (or combined with population and age factors), (Kinnear et al., 2000). In the variables where significant differences were found, Tukey's means comparison tests were performed at 5%.

Results

Populations from the West of Mexico show an interesting variability in the physical and chemical quality of the fruit.

According to the physical analysis, the weight oscilo of 1.34 - 2.62 grs. The fruits that presented the greatest fresh weight, (larger) belong to the populations from Sayula, Jalisco and Tierra Generosa, Nayarit. As for the equatorial diameter are between 12.88-15.68 mm and the polar 12.86 - 15.93 mm, where the fruits of Tecalitlán Jalisco, Tierra Generosa Nayarit, Yurécuaro Michoacán and Tequila Jalisco were the populations that showed the highest values.

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In the chemical analysis in the pulp Although soluble compounds and titratable acidity (AT) include a group of compounds (glucose, fructose and to some degree sucrose) and organic acids (citric or malic), flavor of the tomato depends on the balance between the sugar content (° Brix) and citric acid. The results obtained from the studied populations provide the following: Total Soluble Solids (° Brix) most of the values obtained in this research are between 5.5 - 10.6 ° Brix. The sweetest fruits being those of Tequila Jal., San Miguel del Zapote Jal., Tecalitlán Jal., And La Rosa Tamazula de Gordiano Jal. Commercial parameters require minimum 6 ° Brix. The ranges obtained in citric acid (titratable acidity or AT) were 0.42% - 0.83% Alcaraces Colima and Nayarit Coamiles are the ones with the highest percentage. As for the pH, in general all the fruits present between 4.35 - 5.25; being observed that there is not a significant difference between the different localities, corresponding in general terms to an acidic pH.

Chemical analyzes of the seeds contributed values between the following ranges: Crude protein content between 19.08 - 32.25% the highest is the tomato of Las Palmas Chápala, Jalisco. Crude fiber of 27.36- 44.26% higher than Coahiles Nayarit. Crude Fat 11.52 - 65.06% higher than Yurécuaro Michoacán; Calcium 0.48 - 2.19% the highest Nayarit Coamiles. Phosphorus 0.18- 1.15% higher Generous Earth Nayarit. Ash 3.05 - 6.81% higher in Las Palmas Chápala, Jalisco. Lignin 21.54 - 64.34% higher the fruits of San Miguel del Zapote Jal. Dry matter 72.22 - 95.63% higher Sayula Jalisco and Humeda matter 4.35 - 7.68% higher those of Tecalitlán Jalisco.

According to the statistical analysis there are significant differences in fruit size y Chemical composition of the pulp between populations and between different cycles.

The presence of a significant interaction involves variable responses of the genotypes over time. The variability present in the populations was maintained through the evaluation cycles being the result of an interaction with the environment, of the climatic type of the locality of origin, which leads to the proposal of the existence of ecotypes

Sources of variation	Grades of freedom	Fresh weight (g)		Ecuatorial diameter (mm)		Polar Diameter (mm)		Soluble Solids (°B)		pH		Titratabl (%
		CM	Prob.>F	CM	Prob.>F	CM	Prob.>F	CM	Prob.>F	CM	Prob.>F	CM Prob.
Towns	11	0.666	***	15.8	***	13.9	***	32.2	***	0.19	***	0.12 **
Years	2	5.15	***	109	***	94	***	26.5	***	12.9	***	0.04 **
Interaction	22	1294	***	7.02	***	7.06	***	7.14	***	0.19	***	0.07 **
Error	198	0.98		1.04		0.926		1.2		0.03		0.01
Total	359											

** Significativo (Prob≥0.01), *** Significativo (Prob. ≥0.001)

Table 1 Analysis of variance of physical and chemical characteristics of tomato (Solanum lycopersicum var. Cerasiforme).

Discussion

From the results obtained in this study we can say that the tomato Solanum lycopersicum var. Cerasiforme, easily competes with the cultivated tomatoes as observed in the comparative analysis with the results of the analysis of other works and other types of tomato (Tables 2 and 3)

Parameter	Juárez-López *et al.* 2009 (Guerrero y Puebla)	Juárez-Crisanto *et al.* 2010 (Oaxaca)	Resultados de nuestro estudio (Occidente de México)
°Brix	5.8 – 8.0	4.5 – 9.3	5.20 – 10.8
pH	4.1- 4.4	3.63 - 4.3	4.28 – 5.03
% AT	0.50 - 1.01	0.32-1.45	0.40 - 0.83

Table 2 Comparative analysis with other studies on tomato cultivated in Mexico

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In these tables it is observed that the tomatoes of our study, the ° Brix values are higher which means a better taste (more sweet), increasing the desirable sensorial characteristics that influence the consumer acceptance.

Parameter	Red Cherry tomatoe	Yellow Cherry tomatoe	Ball tomatoe	Study results (Occidente México)
°Brix	6.5	3.9	3.6	5.20-10.8
pH	4.3	4.3	4.3	4.28–5.03
% AT	0.42	0.35	0.34	0.40- 0.83

Table 3 Comparative analysis with studies conducted by Kowalczkety (et al., 2011)

In the last years the different researches oriented to evaluate the benefit in tomato consumption due to its chemical composition has increased the interest to study its medicinal, nutritional and functional value, for the benefits of its consumption, both in the state Fresh as in products derived (juices, sauces, puree, soups, stews among many). There are several reports of epidemiological studies describing the potential of tomato in human health. For this reason we will show the most relevant nutritional and socioeconomic medicinal aspects derived from all these studies in this fruit, to which is added ours.

Nutritional alternative.- The wild tomato Solanum lycopersicum var. Cerasiforme has specific physical-chemical and sensory characteristics that distinguish it from other variants of tomato. Its chemical composition is composed of: carotenoids (lycopene, phytofluene, lutein, phytoene, gamma-carotene, neurosporene, beta-cryptoxanthin, all-trans-beta carotene, cis- beta-carotene, beta-carotene, alpha-carotene and zeaxanthin), Vitamins (A and C), which act as antioxidants, as well as minerals (macroelements: Mg, S, Ca, P and K, microelements: Cu, Fe, Zn and Mg, other Na and Se elements), organic acids (Citric acid), and phenolic compounds (gallic acid, chlorogenic acid, caffeic acid, mirecetin and naringenin) and sugars. (Chavez et al., 2011).

The content of vitamin C (or Ascorbic Acid), is between 8.6 - 82 mg / 100mg in fresh fruit (Guil and Rebolloso, 2009, Crisanto et al., 2010, Méndez et al., 2011). This vitamin is essential for collagen biosynthesis (Li and Schellhorn, 2007). It participates in the activation of enzymes, reducing oxidative stress, in the immune system, protects the respiratory tract from infections, reduces risks to cardiovascular diseases and cancer (Schlueter And Johnston, 2011, Li and Schellhorn, 2007). It is estimated that by consuming 100 g of this fruit, it can cover 90% of the daily requirement of lycopene, which is 75 mg in women and 90 mg in men, minimum to exert its antioxidant action in the organism (Hernández, 2004). It was identified that the minerals are in a higher content in wild tomatoes (Guil and Rebolloso, 2009, Fernández et al., 2011). It is considered that consuming 100 grams of this tomato daily, provides the requirement of 35.2% copper (Cu); 11.2% iron (Fe); 6.4 potassium (K); 5.73% zinc (Zn); 1.76% selenium (Se); 1.2% calcium (Ca); And 0.1% manganese (Mn) (Hernández, 2004, FAO, 2016).

Food alternative. During the harvest season of wild tomatoes, it means an alternative food for the communities that inhabit these areas, and for the places where they market them, replacing it with other types of tomato. For the wildlife that lives in the areas where these tomato populations develop, it is an alternative food for birds, rodents, insects and bats, representing in some cases the only source of food that will provide them with water (as this Fruit has a high content of it), the nutrients mentioned above that are in this fruit.

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This type of studies, because of the nutritional information it provides regarding knowledge of the chemical composition of fruits (proteins, lipids, carbohydrates, vitamins and minerals) of tomato and its components (pulp and seeds), allows to know the nutritional contribution they have These fruits for the consumer, because this fruit has the advantage that their seeds are so small that when chewing or grinding the whole fruit releases its chemical components, taking advantage of the nutrients of the husk, pulp and seeds. The zoologist provides information on the nutrients consumed by the local wildlife, and the nutritionist to have the knowledge of the nutritional contribution of these fruits that will allow you to introduce it into the daily diet as an alternative to other foods during the months when it occurs. It was also identified that one of the most important ecological aspects of the wild populations of tomato Solanum lycopersicum var. Cerasiforme is due to its herbaceous, creeping or climbing plant, the stems extend up to 7 m long in tropical or subtropical places when it has no moisture restrictions and in semi-arid or low rainfall does not exceed 50 cm or 1 (Lobato et al., 2011), thus providing food for some species of wild animals such as insects, bats, rodents and birds, constituting as one of the key plants of the ecosystem in which they develop.

Medical alternative.-Potassium is involved in the regulation of blood pressure, reduces the adverse effect of excess sodium in the blood and reduces the risk of kidney stones. Calcium and phosphorus are bone and tooth builders, with the possibility of reducing osteoporosis by age (Chavez et al., 2011). Iron is part of hemoglobin, preventing anemia. Selenium is part of the glutathione peroxidase enzyme of human erythrocytes. Manganese participates as an enzymatic cofactor of the metabolism of amino acids, lipids and carbohydrates.

Zinc acts as a catalyst for several enzymes conferring the maintenance and structural integrity of proteins and participates in the regulation of gene expression (Hernández, 2004). Carotenoids are antioxidants that have the ability to react with reactive oxygen species that are produced under conditions of photooxidative stress, and together they have a protective effect against prostate cancer and oxidative DNA damage (Porrini and Riso , 2000; Khachik et al., 2002). Lycopene has the ability to modulate the metabolism of androgens, hormones that are associated with prostate cancer and decreased estrogenic activity (Erdman et al, 2009).

Socioeconomic Alternative.- Globally, tomato (Solanum lycopersicum is the second most cultivated vegetable after potato, with 3,744,563 have been planted.Mexico ranks 10th in the world in area planted annually with about 70,000 ha, in our country Is one of the most important vegetables because of the large number of direct and indirect jobs generated by its cultivation, the number of foreign currency entering the country through its commercialization (Lobato et al., 2012).

It also represents an economic alternative, in the main regions of the West of our country where populations of wild tomato Solanum lycopersicum var. Which are consumed or marketed in local markets or nearby cities, thus becoming a food and socioeconomic complement of the communities settled in these areas, which confirms the economic importance of these Populations.

Conclusions

Populations from the West of Mexico show an interesting variability in the physical quality of the fruit; As well as in the biochemical and nutritional quality.

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According to the analysis obtained in our study, both pulp and seeds (because when chewed or crushed) together, they confer a significant contribution of: minerals, proteins, carbohydrates (being a source of glucose and fructose), water Has a high content of it), lipids (providing essential fatty acids), and are a good contribution of vitamins, organic acids, carotenoids, antioxidants, and phenolic compounds, for people and wildlife that consume them.

Wild tomatoes are a good alternative food for the consumer that can substitute for other types of tomato, and for wild animals may represent their only source of food at the time they appear.

The constant consumption of this type of tomato provides the necessary nutrients that can prevent certain pathologies and diseases representing a good medicinal alternative for the consumer.

The production and harvesting of tomato from wild populations represents an important socioeconomic activity for the rural communities settled in the West of Mexico, where it is observed that they commercialize it in the squares, tianguis and some markets. It should be noted that this production is obtained at very low cost (without any anthropogenic energies), which represents for the collectors extra income with little investment. Based on the results obtained, it can be concluded that Solanum lycopersicum, a cerasiform variety, may represent an alternative for the inhabitants and wild fauna that inhabit these areas of the West of Mexico: medicinal, nutritional, nutritional and Socioeconomic

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Feasibility survey of water purification facility: Project – based learning

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Abstract

Background: A survey was done about the feasibility of installing a water purification facility inside of the Universidad Tecnológica Emiliano Zapata del Estado de Morelos. The main was applied project – based learning to integrate different knowledge areas to meet the approach: project management, market research, basic statistics and the industrial process. Working under this scenario student was able to develop new professional skills, developing a project with sustainable focus, since the ecological, social and economic impact around the region where the campus is located was taken into account. Project management was based on best practices described at Project Management Body of Knowledge. The installation of water purification facility would be profitable and the university community is willing to consume the water purified at their own university. Something that was not considered at the beginning of the project was the role of drinking water supplier that university can be taken, because the production capacity of the plant type selected exceeds domestic consumption. Students working under this scenario are able to learn autonomous behavior, since the face real issues and assume role of a businessman, making decisions, looking for their own information sources, developing professional competencies and in this case sustainability commitment.

Project management; sustainability; professional competencies; purified water

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Introduction

Water is a worldwide issue, humans beings needs water to live, and we needed it for many things. According to available data [1], 97 % of the all water is saltwater, 2 % is ice and it is conserved at glaciers and just 1 % remains for human consumption, for this consciousness about water conservation is really important. It is also common knowledge that water from rivers or springs contaminated in different ways, including the lack of which is a resource that besides the lack of people is running for caring this essential resource for life on the Earth. Therefore the treatment and responsible use of water is a topic related with social and sustainability aspects. The Universidad Tecnológica Emiliano Zapata del Estado de Morelos (UTEZ) [2] committed with its environment and taking care of it, started with its institutional program of sustainable campus in 2011. One of the three work axes of this program is the use treatment and responsible use of water, which implies:

- Treatment of wastewater to use in irrigation.
- To avoid or eliminate and reduce water leaks inside of the campus.
- Diffusion of information about the caring of water and the responsibility of each one has about it.
- The useless waste of water during the filling of elevated tanks or cisterns. This can be reduced applying the technology, by the installation of automatics control systems.

During the development of the project, one new one showed up: the installation of a purifier water plant. This could have an immediately sustainable impact in the region and with the internal and external community of the university. UTEZ is located at 18°51'2"N, 99°12'3"W [3], and it is really warm most of the year. UTEZ has in average a temperature of 30 degrees along the year [4]. Therefore water consumption is high, mainly by students because classrooms have no air conditioning. These two conditions: water caring and warm weather; hold the development of a feasibility survey about to install a purifier water plant inside of the university campus.

Water is a vital resource for humans, in Mexico it is common knowledge that the days when the water was taken directly from the tap are long gone, as most people consume bottled water, according to the survey conducted into the campus. It is also common knowledge that water from rivers or springs contaminated by different reasons, including the lack of which is a resource that besides the lack of people is running for caring this essential resource for life on the Earth.

The idea of installing a purifying plant in college with the idea of purifying water provided by the municipality and be the main, if not the only, supplier of bottled water on campus was raised. The objective of this work is to perform a feasibility study in relation to the cost and return on investment for installing a purifying plant in which it UTEZ provide bottled water into the campus and neighboring institutions UTEZ.

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This is a new service that the university offers its students and the general public, the cost will be lower than current providers and quality shall be certified by the relevant agencies. Another inherent benefit to project is the image of the UTEZ to the general public, since the internal and external community will recognize that the UTEZ has social commitment, serving the needs of the community with quality and commitment to the environment the region where it is located.

Frame of reference

To apply marketing techniques reviewed in the classroom, project learning technique was used, which involves the student in a more profound way, making it co-responsible for their learning process. The student conducts the administration of a project that has application in the physical world, beyond being just an academic exercise. Project-based learning is well documented in the literature [5 – 8]. According to the PMBOK [9] projects can be divided into five phases: initiation, planning, executing, monitoring and controlling, closing. This methodology was used in project management. The project is implemented in four months, at the end of which is due on feasibility study to install a water purification plant in the university campus. By objective was divided into three main: domestic market analysis regarding water consumption, investigation and analysis of the different providers of purification plants, general conditions for installation. In this way the student during the project integrates the knowledge acquired in the classroom to real-world situations, to develop skills needed in the profession, Figure 1.

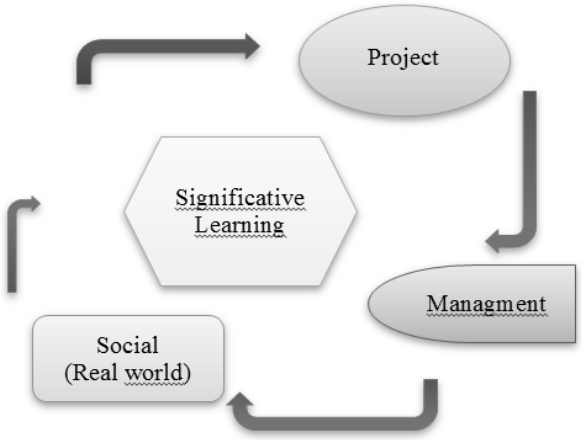

Figure 1 Different factors are involved in the significant learning process

Methodology

For project management the PMI best practices were followed [9]. According with PMI, there are five project phases, Figure 2.

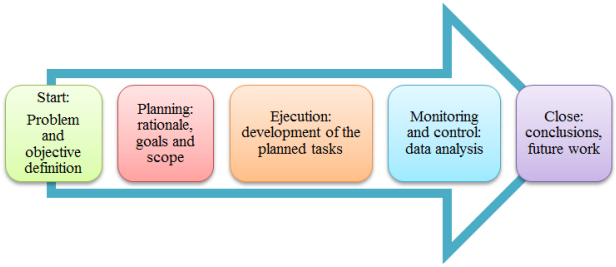

Figure 2 Project management phases

In the classroom the basic tools of market studies are taught, important and general aspects that make a study of this type, so that the student is able to identify characteristics that may be endemic of your project and adapt techniques project implementation. The market analysis is widely described in the literature so it is not considered necessary to deepen the description of the item [10 – 13].

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This research helps to create the strategic plan of the company, is preparing to launch a product or facilitate the development of products launched depending on the lifecycle [11]. It is most attached to the need for the project, and to position the product in the UTEZ community will be critical in the success of the final project. It is important to know the target market which will give the satisfactions to perform an accurate analysis of cost - benefit and estimate the recovery time of the investment.

It is very clear that the target market is fully identified [12,13]: the student population UTEZ therefore this target market analysis is performed to obtain information and establish confidence level on the introduction of the product.

The findings are used to make decisions that will solve specific marketing problems, therefore, market research is beneficial in various situations, but the decision that is made is not automatic. This decision can be based on:

- The cost - benefit.
- Resources available to conduct market research.
- Administration attitude towards implementation

In order to obtain the data for analysis using the technique of questionnaire or survey application [10], define the variable to monitor and questions should be properly structured. A survey was applied selecting a sample of 200students of both shifts, diversified in all areas.

The objective of this survey is to identify the preferences of the population sample, with respect to consumption of bottled water and identify the size and ideal for introducing this new product in the domestic market UTEZ price. The market study was also conducted to identify the best supplier of water purification plants. The strategy was searching online and visiting nearby locations within the community. For the project the student followed the best practices of the PMBOK (PMI), following the sequence described in Figure 2. The first points have already been discussed to this part of the rest will be described in the following section.

In the start-up phase, the important aspects of the project are detailed. The initial project meeting with the two advisors and the young researcher is performed. The projects requirements are underlined, besides of the objective, the stakeholders are listed, an all of this important things are put together on the project chapter (PMBoK), and it is signed. This is a very important document because, is going to be the guide for the successful development of the project, and every time researchers get lost, they can go back and review it the objective, the scope and so on, to get back the project in the right way.

In the planning phase all strategies are designed, and the schedule of each of them, actually of the all project development is planned. In this paper project, had to be developed in four months, so the schedule design activities for this period, and also there is planned reviews during the development of the project to review the status with the stakeholders, but also to be assure everything is going good.

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At this stage the appropriate instrument for data collection was chosen, what in this job the questionnaire was selected. Selection of the questions to get the really important data in a fast way is made. In this survey the authors chose the sample size to perform the questionnaires into the campus. Basics statistics to analyse data were done using a spread sheet. Questionnaires were applied to two hundred students from different shifts and careers.

During the implementation phase, all scheduled activities are done, for example the market survey and the analysis of different suppliers of water purification plants, with the purpose to get the analysis of cost benefit to install it inside of the UTEZ campus.

The monitoring and control phase is to take care that the project is executed in a timely manner, and in case of some setbacks appear react promptly or even are able to predict the occurrence of unanticipated events.

In closing the review of compliance with the purpose and planned actions is made. The project is finished with the feasibility survey. Therefore the proposal to install the purifier water plant inside of the campus is presented to the university authorities to make an educated decision.

Working under this scenario student gains skills in different areas of knowledge strengthen the knowledge acquired in the classroom and acquire training as a researcher. In addition it gains autonomy in managing their own learning recognizing the environment in which it operates, and evaluating their strengths and their weaknesses.

This kind of autonomous behaviour gives to the student also competences in relation to seek their own sources of information to discriminate in terms of quality of the same, whether printed or electronic. This scenario give to the student an integral education, providing meaningful learning, and that the institution earns in the sense that they have the data to make an educated decision and have the social, economic and environmental benefit.

Results

The survey starts getting the information about how many litters by week of drinking water the university is buying, and the cost for buying them, Table I. University is paying about 6896 usd for drinking water concept by year. And the consumption of drinking water by year is 1600 litters approximately. At the moment that this survey was done, there were 2500 people at university, including administrative people and students. Once this important data is known, the next step is research about purified water plants providers. All of these data are about drinking water that university; data from student's community are not included. Authors considered a very good estimation about ROI (Return Of Investment) could be done with these data.

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Drinking water by week		
Place	Liters	Cost
Building three	300	23.91
Building two	240	20.44
Building one	200	18.01
Talleres	240	14.17
Building four	60	5.31
Library	40	4.13
Principal building	140	14.46
CEVISET	220	22.73
CECADEC	160	9.45

Table 1 Liters by week of drinking water and their cost

The research was done going to visit directly the providers at their plants or calling them by phone or by e-mail. Based on this research "Purisystem" was the optimum option for university, Table II, since according with data, university does not need a huge production level. However data shows something really interesting, university could by the drinking water provider for other institutions in the neighbourhood. It means purified water at campus could be consumed by the internal market and also there is an opportunity for external market.

Drinking water by week		
Place	litters	Cost
Building three	300	23.91
Building two	240	20.44
Building one	200	18.01
Workshops	240	14.17
Building four	60	5.31
Library	40	4.13
Principal building	140	14.46
CEVISET	220	22.73
CECADEC	160	9.45

Table 2 Comparison of different providers of drinking water plants

This two starting steps, shows that installing a purifier water plant in the campus looks like a good business opportunity, besides another value added points, like social and ecological University image. More deep analysis must to be done to take into account another kind of issues, the adaptation of current facilities, the health permissions to operate, bottles and jug containers, stickers basic supplies for plant operation, people to operate it, and so on. All of these data needs to be put together to have a good estimation for the ROI, however the feasibility looks so far so good. Student has made a real marketing survey and also a research about choosing the provider. Students get competences about autonomous performance and skills to select their own information sources, negotiation getting the right data and social commitment.

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Students have opened the panorama about all of these no planned things in the project start and that has to be done for a complete survey.

The next project step was, perform the internal market survey, for this case data source was the questionnaires applied to some selected sample from the total UTEZ universe. The sample size was selected according with the researcher criteria [14]. Questionaries' were answered by students, staff and some external service providers to have a heterogeneous sample and data from different possible customers. According with data coming from the questionnaires most of the people surveyed get their drinking water from Jug water source, this one is the 25 litters bottle i.e. familiar size. Also it means most of the people use one container more than once and just wash and refill it.

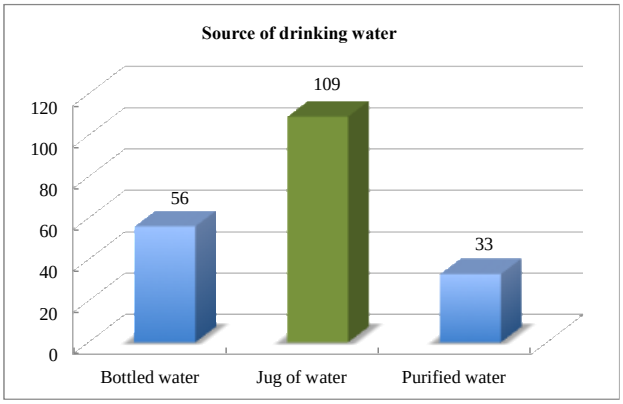

Figure 3 Jug water is the preferred drinking water source.

Another important data is the preference of people about the size of the bottle, in this case surveyed people prefer one litter size more than another one, Figure 4.

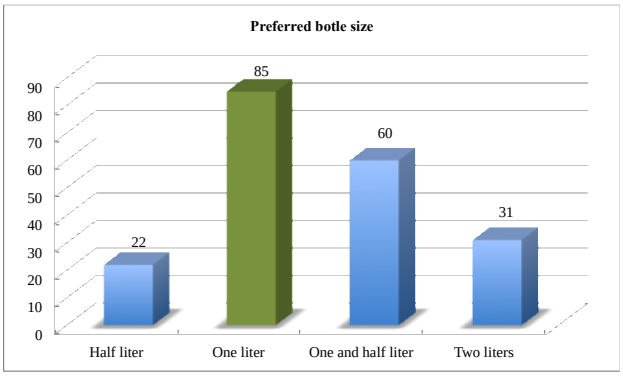

Figure 4 Surveyed people prefer one litter presentation.

Maybe this size is preferred due to could be easier to carry on with you, and the refill containers are in this presentation. It is also important to know if the people care about the brand of the bottle water, because is common knowledge that some products are consumed by fashion, by imitation or just because the advertising. The data shows that for approximately 71 % of university community does not care about the brand of bottled water, Figure 5.

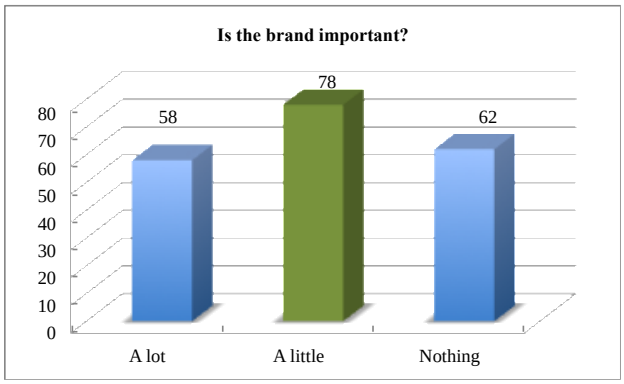

Figure 5 The brand of the bottled water has no value added for most of the people.

For the cost-benefit analysis is important to know how much is people are willing to pay for the purified bottled water manufactured at university campus. The most common price for one litter size of bottled water is $0.74 usd, Figure 6.

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All data analysed so far, shows that installation of a purifier water plant inside of the campus, because university is paying almost the same money by year for drinking water than the cost of the plant, and internal market is able to accept the own university purified water brand. There is a goal market identified and that's is going to accept the product and the necessary investment is almost equal to the actual annual payment for drinking water.

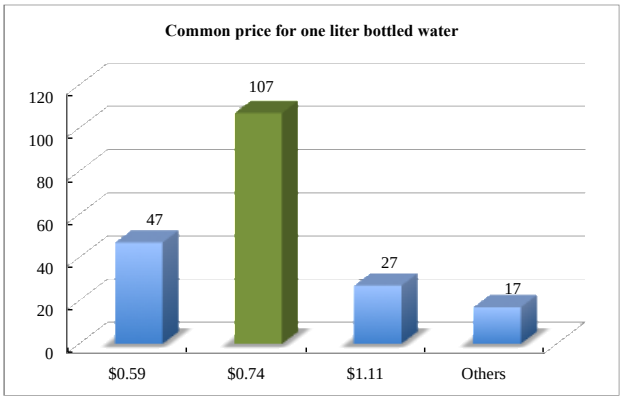

Figure 6 The price of the bottle can be lower than the most common current price.

Conclusions

Project – based learning is a scenario that lets integrate different skills, due to student needs to apply knowledge learned from the classroom and needs to develop autonomous competencies. Project management applied in the development of this kind of projects let, and in some way dare the student to figure out the way to get enough information to make decisions and propose possible solutions. Make students more able to prevent some issues during the development of a project and react in a rapid way if some emerge.

Purifier water plant installation is a feasible and profitable project.

This kind of project are the ones that start just like a simple idea and give as a work product the born of a new micro enterprise with high confidence of success.

In this type of feasibility studies should include analysis of the environmental impact, since in sustainability issues should be directed not only at work but a feasibility study to consider the ecological impact. In this work it was excluded, not from lack of courage or an underground act, but not to be one of the academic strengths of UTEZ. The environmental impact caused by the installation and commissioning of water purification plant is scheduled within the project management, but as a future work. For this purpose the integration of a multidisciplinary team, where knowledge is supplemented in the social area, business development and marketing, environmental, health and project management is recommended.

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Humidification and dried seed like alternative as recover of germination and vigor deteriorate seed corn

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Abstract

One of the aspects that contribute to loss of the germination and the vigor in seeds is the time and conditions of storage. With the propose to recover the germination and vigor in seed of deteriorated maize, in this work a series of humidification treatments and drying of seed were made during two phases; in the first seed it was imbibed in the times of 2, 4, 6, 8, 12, 24, 36 and 40 hours in water as much purified and water without purifying; in the second, seed was imbibed in the times of 2, 8 and 12 hours adding products to him like activol, gibiotin, gibgro, biozyme, maxi grow, calcidef y calciofem. The evaluated variables were standard germination and speed of emergency, completely analyzing themselves in a design at random in a factorial adjustment. In first stage the analysis of variance we throw difference significant in standard germination and speed of emergency over time of imbibitions and type of water, the best periods of imbibitions corresponded to 12 hours. In the second phase, analysis of variance for the two variables significant differences in time and the products were found. Better product Activol dose was 0.2 g / l of water to 12 hrs imbibition, followed by product Biozime and Calcidef both in doses of 1 g / l of water imbibition 8 hrs respectively.

Corn, drie humidification, imbibition, standard germination, speed of emergency

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Introduction

Deterioration is defined as the degenerative and irreversible changes that occur after the seed has reached the maximum level of quality (Mc Donald and Nelson, 1986). Wetting and drying of the seeds reinvigorates accelerates and uniforms germination under optimum and adverse conditions (Hacisalihoglu and Ross, 2010). At the same time, several physical and chemical treatments are currently known to reinvigorate deteriorated seeds; Such as polyethyleneglycol (PEG) and KNO3 (Heydecker et al., 1973, Khan, 1980, Priestley, 1986, Mayer and Mayber , 1989, Sánchez et al., 2001). In the present study with the purpose of recovering the vigor and germination of deteriorated maize seed, a series of treatments were carried out using the technique of wetting and drying of seeds and the incorporation of different chemicals containing gibberellic acid and calcium. Objectives were to: a) determine the optimal imbibition period in impaired maize seed, and b) evaluate seed response to be imbibed in two types of water and with different chemical products.

Methodology

The work was carried out in the University Center of Biological and Agricultural Sciences of the University of Guadalajara. Hybrid seed of deteriorated maize with 70% germination was used. For the research, a germinating stove at constant temperature of 25 ° C, germinating paper, unpurified water, purified water, sand bed for planting of 1x2m., Stanlite electronic moisture determiner, Reagents:

Calcidef (tablets of: Lactate Maxi-Grow (gr / 1 = auxins 0.09, gibberellins 0.10, cytokinins 1.5, N 6.6, P 13.3, K 13.3, Ca 2.0, calcium gluconate 2.94 g, calcium carbonate 0.30 g, equivalent to 500 mg of ionizable calcium) Mg 4.0, Fe 17.2, Zn 26.5, Mn 13.3 and Cu 13.3), Calcium fem (Calcium 600 mg, Vit 749.51 mcg, vit.D2 10 mcg), Activol (10 g Ag3), Gibgro (10 g Ag3), Gibiotin (10g Ag3), Biozyme (Gibberellins 77.4ppm, AIA 33ppm, zeatin 128.7ppm, extract broth 79.10% extract organic matter 0.74%).

The research was developed in two phases: In the 1st. Phase was carried out the wetting-drying of the seed, incorporating water type factors and imbibition time; While in the 2nd Phase were incorporated the factors chemicals + dose + imbibition time.

1st. Wet-drying phase: The seed was subjected to nine imbibition times 2, 4.6, 8, 12, 18, 24, 36 and 40 hrs, plus the control without imbibing. They were then dried at room temperature for 5 days, then seeded in both germination chambers and seedlings. The following data were taken: Initial moisture content and Moisture content after imbibition period. The following variables were measured: 1. Standard germination. 2. Emergency speed (data were taken on the number of germinated seeds per day x treatment / plot for 15 days). The emergency speed calculations were made according to the methodology proposed by Maguire (1962). The experimental design was completely randomized with 4 replicates in a split plot arrangement where plot A corresponded to the imbibition time and plot B to the water types. As a comparative test of means, the Significant Minimum Difference (DMS) was used at 99% probability. In the germination percentage variable the data obtained were transformed to the sine-arc function.

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2nd Moistening phase - drying + product dose + imbibition time. In this phase 3 imbibition times (2, 8 and 12 hrs) were used, combining with 7 chemicals at 3 doses per product (1gr, 0.5 g and 0.2 g / 1 of water respectively), obtaining 63 combinations or treatments. Standard germination and emergency speed were taken as variables. A completely randomized experimental design was used, with 4 replicates in an AxBxC factorial arrangement where factor A corresponded to the 7 chemicals, factor B at 3 doses and factor C at 3 imbibition times. As a comparative test of means, the DMS statistic was used at 99% probability.

Results

Moisture content. After imbibition, the highest moisture content of the seed was at 40 hrs. In purified water (35.58%), and at 12 hrs in unpurified water (35.4%); the difference in time may be due to the fact that purified water in theory has less salts than ordinary water, the seed reaching a higher moisture content in unpurified water in a shorter period. As reported by Delouche (1979) and Bidwel (1990); the absorption of water by a seed essentially comprises a special type of diffusion called imbibition. Water or other moving materials move from a site or area where the concentration is high, to an area where the concentration is lower, by diffusion until equilibrium is established. And after the drying period, the lowest moisture percentages were obtained in purified water in the imbibition treatment of 6 hrs, and for the unpurified water at 24 hrs. The treatments that lost the least amount of water obtained during the imbibition were in the 12 hrs. With purified water and 18 hrs. With unpurified water.

Standard germination and emergency speed. In the analysis of variance, significant differences ($\alpha \leq 0.01$) were obtained in the variables studied and in the type of water.

When performing the test of means (DMS) in the standard germination test with unpurified water, imbibition treatments that exceeded the percentages presented by the control (70%) were at 6, 12 and 36 hrs. (80, 90 and 86% respectively); While in purified water the imbibition periods that exceeded the control were at 2 and 12 hrs (80 and 85% respectively). Although in the purified water the highest moisture content was obtained at 40 hrs, a drop in germination was observed when compared to the control (<70%), which suggests that an imbibition period above 40 hrs . Can cause a deterioration in the seed possibly due to deficiencies of oxygen within the seed. These results agree with Arellano, et al; (2000); In a similar experiment they obtained percentages of germination above the control with 18 hrs. Of imbibition of the seed in running water. Meanwhile, in the variable emergency speed the control had an average value in this variable of 13. The highest value of vigor in unpurified water corresponded to 12 hrs (17.6). While in purified water the best imbibition periods corresponded to 2 and 12 hrs (15.34 and 14.70 respectively). Some species have the ability to preserve, during a temporary dehydration, the physiological changes as the differential expression of proteins induced by the hydration of the seeds. This is known as "hydration memory" (López-Urrutia, et al., 2014). Sharma, et al. (2014) have studied the influence of the wetting and drying cycles on some species, which have responded with a higher germination in treated seeds than the control or control.

2nd stage wetting - drying + chemical treatment + imbibition time. In the second phase significant differences ($\alpha \leq 0.01$) were obtained in the variables germination standard and emergency rate in the factor product, time and dose. Germination percentages above 90% and high values of emergency speed (15-20) were achieved by incorporating the studied products into the water.

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In general, the best percentages of germination occurred with the use of Activol product at doses 0.2 gr / lt water at 12 hrs imbibition and 0.5 gr / lt water at 8 hrs, followed by the product Biozime and Calcidef both in doses Of 1gr / lt of water to 8hrs of imbibition respectively.

Conclusions

The imbibition time played a decisive role in the variables germination and emergency speed, finding that the optimal period of imbibition in both types of water was at 12 hrs. With a greater increase of 15% in germination and favoring the rapid emergence of the seed when incorporating products based on gibberellic acid and calcium.

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Water quality of the Atoyac river in the Tentzo microbasin Puebla, México

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Abstract

The water quality of the River Atoyac in the Tentzo microbasin in Puebla, Mexico. Was evaluated five sampling stations were selected on the Atoyac River according to the local inhabitants' use of the water: human consumption; agricultural use; and recreation. The physico-chemical parameters (pH, dissolved oxygen, temperature, water flow, electrical conductivity, DBO_5, nitrates, phosphates and ammonium) and microbiological matter (fecal coliforms) were determined over the course of a year, in accordance with the Official Mexican Standards (NOM). The results show that the average values for these parameters across almost all of these months exceeded the Maximum Permissible Limits (MPL) according to the current Mexican legislation (NOM) and indicate a high level of risk for the public health of the local populations.

***Escherichia coli*, water quality of the Atoyac River, Sierra del Tentzo, Atoyatempan and Molcaxac in Puebla**

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Introduction

At a global level, developing countries treat at least 10% of their water, a situation very similar to that in Mexico, where the percentages are closer to 20%.

The majority of the liquid is discharged into rivers, lakes, or the sea without any prior treatment, causing their contamination, and the consequent reduction of available water (SEMARNAT, 2002). Mexico has severe problems with water quality and its water resources are oriented around using the receiving water bodies for pollutant loads. At least 12 million people in Mexico lack drinking water and 23 million do not have a sewage system in their homes, while three out of ten inhabitants of the rural sector do not have access to piped drinking water (FUSDA, 2008).

Hydrological Region (RH-18) of the River Balsas is one of the most important Hydrological Regions in the country, occupying the Central and Southwestern region of the State of Puebla. The River Atoyac belongs to this region and comprises the section of river flowing towards The Southeast and passes through the municipalities of Atoyatempan and Molcaxac in the Sierra del Tentzo State Reserve. (CONABIO, 2011).

From the bibliographical review conducted on the contamination of the River Atoyac basin, there are very limited reports, which have not been updated. With regard to the contamination of the river in the Tentzo microbasin, only the microbiological study by (Rodríguez et al, 2013) was found. It was concluded that Atoyatempan and Molcaxac are at risk from the use of water from the river, with these populations at risk of contracting diseases produced by the bacteria detected: Escherichia coli; Pseudomonas sp .; K. pneumoniae K. oxytoca; And, Morganella sp.

The River Atoyac represents the economic, social and cultural basis for the development of the municipalities of Atoyatempan and Molcaxac.

This study sought to evaluate the quality of the water and the risk to public health of the populations of Atoyatempan and Molcaxac as derived from the various uses of the river water. It is hoped that this information will lead to improved planning for the use of the water resources found in the microbasin. To date, no physical-chemical studies on the water quality of the River Atoyac have been reported in the region.

Methodology

The research was conducted in the period 2012-2014. Five sampling sites were selected in the microbasin according to the water use in each of the municipalities (Figure 1, Table 1). Sixty samples were undertaken in triplicate (Mitchell, *et al*. 1993). This research used the NOM (Table 2).

Transparency was measured *in situ* with a Secchi disk, while the current velocity (m/s), the pH, the concentration of dissolved oxygen (mg O_2 L^{-1}), the temperature (°C), and the electrical conductivity (µS/cm) were taken using the Quanta® Hidrolab probe.

The conservation of the samples was undertaken according to NMX-AA-003-1980. The parameters analyzed in the laboratory were hardness (mg L^{-1} $CaCO_3$), chlorides (mg L^{-1}), and carbon dioxide (mg L^{-1}), with the measurements undertaken using indicators from Hanna Instruments. Sulfates (mg L^{-1}) were measured using the Spectronic 20d spectrophotometer, while the nitrates (mg L^{-1}) were measured with the Hanna Instruments.

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The level of ammonium (mg L^{-1}) was taken with the Hach spectrophotometer and the biochemical oxygen demand (DBO_5 mgL^{-1}) was taken using the BOD Trak™ II-Respirometric BOD Apparatus. Each parameter was measured three times, from which the average value was obtained.

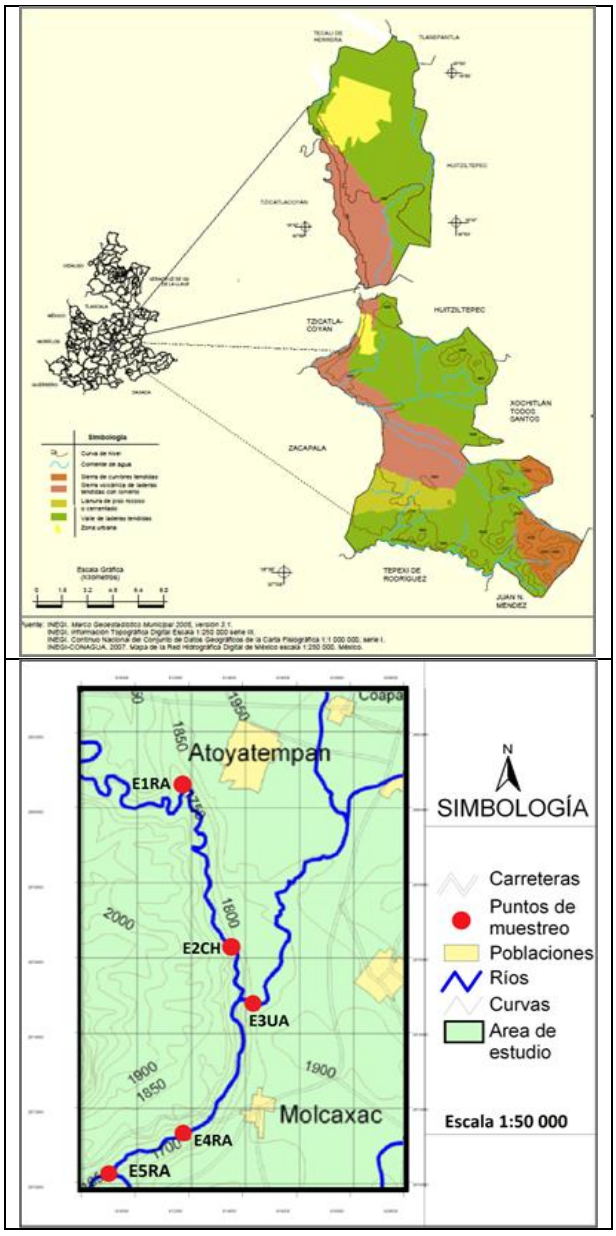

Figure 1 Geographical location of the Municipalities of Atoyatempan and Molcaxac in the State of Puebla and collection sites (INEGI, 2001, 2010)

The Most Probable Number (MPN) and the confidence limit for the bacteria of 95% were determined using the multiple tube technique with three dilutions and three replicas, in accordance with NMX-AA-42-1987, for total coliforms, fecal coliforms (thermo-tolerant), and presumptive *Escherichia coli*.

Sta	Water Use	Coordinates		Observations
		N	W	
E1 ER	Atoyatempan River's beginning	18°48'45.14"	97°55'39.25"	River's shore with tropical deciduous forest vegetation
E2 AP	Water used for human consumption in Atoyatempan	18°46'05.85"	97°55'01.23"	Water coming from springs nearby the Atoyac River, then taken to cisterns
E3 RA	Atoyatempan water used for farming irrigation	18°45'45.04"	97°54'49.38"	There is a large quantity of garbage
E4 RR	Molcaxac, water used for farming and recreation	18°44'05.67"	97°55'30.60"	Puente de Dios, tropical deciduous forest vegetation, geological formations, caves and caverns
E5 RS	Water used for recreation Molcaxac River's end	18°44'00.03"	97°55'41.71"	Cola de Caballo, area visited by tourists

Table 1 Recollection Stations in the micro-basin

The method was based on the inoculation of aliquots from the sample, diluted or undiluted, in a series tubes containing liquid culture medium with lactose. A series of three dilutions (10 mL^{-1}, 1.0 mL^{-2} and 0.1 mL^{-3}) were used and incubated at 35 ± 1°C or 37±1°C for 48 h. The bacterial cultures were examined at 24 and 48 h, with those presenting turbidity and the production of gas and acid were considered positive. The positive tubes were placed in lactoce broth as a confirmatory test in accordance with NOM-127-SSA1-1994.

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NOM	Description
NMX-AA-003-1980	Wastewater. Sampling.
NOM-001-SEMARNAT-1996.	Maximum permissible limits for contaminants in the discharge of wastewater in national waters.
NOM-003-SEMARNAT 1997.	Maximum permissible limits for contaminants in treated wastewater that is reused for public use.
NMX-AA-42-1987	Determination of water quality from the Most Probable Number (MPN) of total coliforms, fecal coliforms (thermotolerant) and presumptive *Escherichia coli*.
NOM-112-SSA1 1994	Goods and services. Determination of coliform bacteria. Most Probable Number technique.
NOM-127-SSA1-1994	Environmental health. Water for human use and consumption – permissible quality limits and treatments to which water must be submitted for its purification.

Table 2 The NOM used in this study

The Student's t-test was applied to the results obtained with a 95% confidence level. The statistical analysis program used was the R commander program. The program Minitab was used to show the behavior of the most significant results in the variables analyzed in both the rainy and dry seasons. In order to identify the relationship between the physico-chemical variables and the concentration of *E. coli* in the sampling sites, for each season of the year, correlation analysis was conducted using the Spearman coefficient (rs) with a significance level of $p < \alpha = 0.5$.

Results and discussion

The River Atoyac in the Sierra del Tentzo watershed presented average temperature values of 17°C - 22 °C. The temperature oscillated between 18°C and 22°C in the rainy season and 17°C and 20°C in the dry season. The average values for transparency oscillated between 0.10 cm and 4.0 m. Station E3RA presented the highest turbidity levels in the rainy season from July to October and reached 0.10 cm in the month of April. This behavior coincided with the increase in water flow, the current velocity and the loading of a large quantity of solid waste in suspension (Figure 2), which constituted a limiting factor in the development of living organisms (Fernández, 2010).

A minimum turbidity of 4.0 m was observed at E2AP station in november and february. The depth of the River Atoyac varied between 2.20 m in the rainy season and 0.60 cm in the dry season.

In physical terms, parameters such as temperature, transparency, and current velocity and depth show that the behavior of the water was homogenous across all the months of the year sampled, and were found to be within the standards applied. The highest average value registered for electrical conductivity was at station E3RA in comparison with the other sampling sites in the rainy season, with values oscillating between 60 and 250 µ S/m, while the lowest registered was at station E2AP, which was from 50 to 140 µ S/m in the dry season.

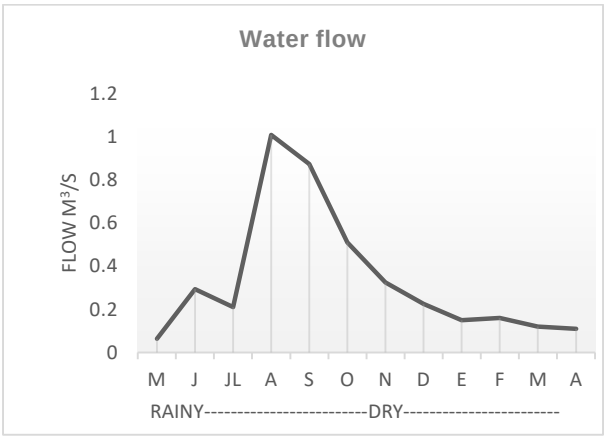

Figure 2 Water flow of the River Atoyac Microbasin in the rainy and dry seasons

It is important to note that during this same period, higher concentrations of *E. coli* were also found, with the highest recorded at station E3RA. The lowest levels found were at station E2AP (Figure 7). These results show that the increase in the concentrations of ions in this season could be due to the increase in the decomposition rates of organic material, coinciding with those reported by (Chalarca, *et al*. 2007; Rodríguez, *et al.* 2013).

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NOM-127-SSA1-1994 and NOM-001-SEMARNAT-1996 indicate that the pH values must be between 6.5 and 8.5. Across all the stations in both seasons, the average values vary in a range from 7.3 to 9.0, which is most likely due to the soil composition, in which calcium carbonates predominate, which in turn leads to water with a high level of hardness. In general, values of pH close to 7.0 are expected to be found in an aquifer (Chapelle, F. 1993). The values obtained for calcium carbonate in the rainy season oscillate between 135 and 480 mg L^{-1}, and between 180 and 570 mg L^{-1} in the dry season. In all cases, the values are found to be below the maximum permissible limit.

The highest concentrations were recorded in the months of March 570 mg L^{-1} $CaCO_3$ and April 540 mg L^{-1} $CaCO_3$, exceeding the permissible limit according to NOM-127-SSA1-1994, which stipulates 500 mg L^{-1} $CaCO_3$, and the Federal Law, which establishes 400 mg L^{-1} CaCO3 as a permissible limit. From the results obtained, it can be inferred that the water in the watershed is alkaline. It can also be inferred that the hardness level found in the rainy season can be classified as moderately hard, while the hardness found in the low water season can be classified as very hard, due to the geology of the microbasin (Navarro, *et al*. 2013).

The average chloride values recorded at all the stations, except those recorded at station E3RA, were less than a 100 mg L^{-1} and higher than 50 mg L^{-1} and were found to be within the NOM. The levels recorded at station E3RA during the dry season exceeded NOM-127-SSA1-1994 and reached values of 1050 mg L^{-1}, with the maximum acceptable value being 350 mg L^{-1} (Figure 3).

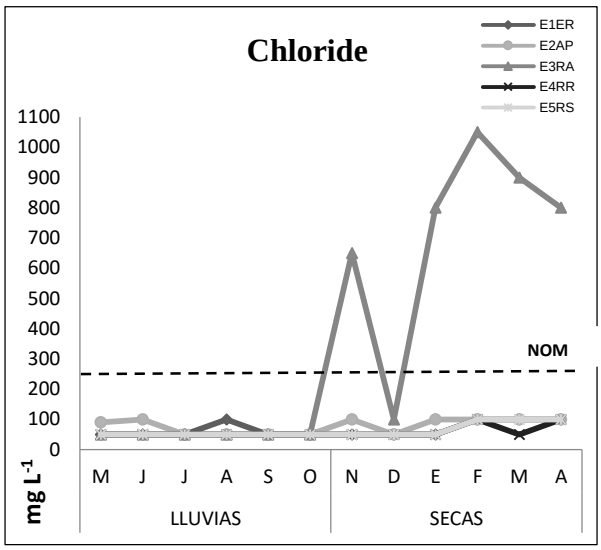

Figure 3 Average values for chlorides obtained at each station.---Permissible limit (NOM-127-SSA1 -1994)

These results may indicate contamination in that waste material of animal origin always has considerable quantities of these salts. These results coincide with the high levels of ammonium, above 10.0 mg L^{-1} (Figure 5), which indicate ammonia contamination, produced by the decomposition of urea by bacteria. Relating these ammonium values to the low or null levels of dissolved oxygen recorded in the dry season (Figure 4) values that coincide with the increase in *Escherichia coli* reported by (Yesenia, *et al*. 2013) (Figure 7) and which is an indicator of fecal contamination could suggest that the high concentrations of chlorides recorded at station E3RA in the dry season show the presence of a higher quantity of organic material compared to the other sampling stations in the watershed. According wing NOM-127-SSA1-1994 (water for human use and consumption) and NOM-001-SEMARNAT-1996, did not indicates permissible levels of oxygen in the water. The literature reviewed here indicates that while dissolved oxygen in water does not have an influence on agriculture, it does constitute a significant indicator of ecosystem health.

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The average values for dissolved oxygen are found to be between 4.6 mg L^{-1} and 10 mg L^{-1}, with homogenous behavior at all sampling stations, except for station E3RA. This station presented maximum oxygen levels of 4.0 - 0 mg L^{-1}, which could be due to both rain and sediment from decomposing organic material. From August to September, the value increased to 2.5 mg L^{-1}, and then decreased dramatically in the October-April period to 0 mg L^{-1} (Figure 4).

These results demonstrate anoxic conditions and a contaminated river (Lampert and Sommer, 1997). This could be due to wastewater discharge by the local populations into what is known locally as Barranca del Águila of large quantities of organic matter, which increase the concentrations of bacteria (Figure 7), which, in turn, on decomposing the organic material, consume oxygen. This decrease in the concentration of oxygen in the water produces, in turn, the death of aquatic organisms, upon which anaerobiosis and the consequent bacterial putrefaction of proteins occur, resulting in the release of methane gas and hydrogen sulfide, a foul-smelling toxic gas characteristic of the region (Brooks, D. 2004; Breitburg, D. 2002; Melrose, *et al.* 2007).

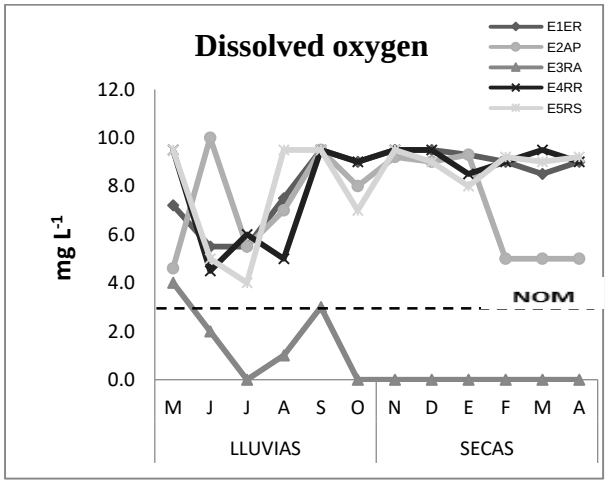

Figure 4 Average values for the dissolved oxygen obtained in the rainy and dry season at each sampling station. (Fernández *et al*, 2010)

The average values for nitrates varied at an interval of 10.1 - 39 mg L^{-1}, values which exceeded the limits established by NOM-127-SSA1-1994 of 10 mg L^{-1} NO3, and by the Federal Law for potable water use, which indicates that the permissible nitrate limits must be from 10 to 5 mg L^{-1} NO3. This increase could be due to the consumption of nitrogen compounds, which are commonly used in the agricultural practices of the region, such as inorganic fertilizers based on phosphorus and nitrogen, and which are received in the watershed. The speed with which these substances are carried is greater than the speed with which they are degraded, producing both soil contamination and the consequent contamination risk to the River water (Fernandez, *et al*. 2010).

In no case did the average sulfate ion values obtained exceed the permissible limit set by the NOM, which is < 400 mg L^{-1}. The values oscillated between 30.2 and 110.7 mg L^{-1} in the rainy season and between 6.8 and 98.6 in the dry season.

The average ammonium values obtained in the rainy and dry season follow a similar trend across all sampling sites and exceed the limits permitted under both the Federal Law, which stipulates 0.06 mgL^{-1}, and NOM-127-SSA1-1994. The average values oscillated between 40 and 75 mg L^{-1}. The highest ammonium concentration was recorded at station E3RA, where the water is used for agricultural irrigation, with values oscillating between 69 -75 mg L^{-1}. The results show that the ammonium levels are above 10 mg L^{-1}, which indicates ammonia contamination caused by the decomposition of urea by the bacteria present in wastewater (Figures 5, 6 and 7).

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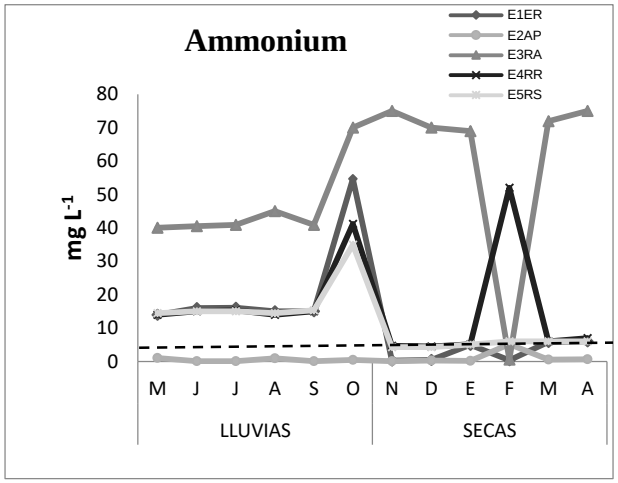

Figure 5 Average ammonium values obtained in the rainy and dry seasons at each sampling station.--- Permissible limit (NOM-127-SSA1-1994)

Relating the ammonium values obtained to the increase in organic material characteristic to the region points to an increase in the bacterial populations and a consequent decrease in oxygen levels. Once all the oxygen has been consumed, anaerobic decomposition commences, producing methane, ammonium, and hydrogen sulfide, a situation which was observed at station E3RA. The low concentration of ammonium in the potable water at station E2AP, between 0.1 and 5.2 mgL^{-1} for both seasons of the year, was found within the limits set by the NOM. The other sampling stations did not comply with the NOM (Figure 5). Both the ammonium ion and the nitrates are typical indicators of water contamination and indicate the degradation of organic material.

According to the National Water Commission (CONAGUA, 2013), DBO_5 values above 30 mg O_2 L^{-1} are characteristic of highly contaminated water, while values below 3 mg O_2 L^{-1} indicate very low organic contamination. Following these criteria, and according to the DBO_5 values obtained at the five sampling stations, the water from the microbasin is found to be within the contaminated category throughout the sampling period (Figure 6).

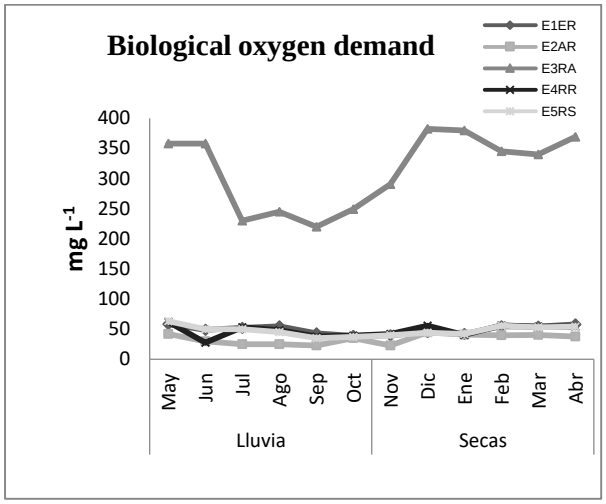

Figure 6. Values obtained for the biological oxygen demand (DBO_5) in the rainy and dry seasons at each sampling station

In accordance with NOM-001-SEMARNAT-1996 for the public and urban use of water, the DBO_5 values obtained oscillate between 23 and 63.1 mg O_2 L^{-1} were found to be within the maximum permissible limits, except E3RA sampling station. The average values at station E3RA oscillate between 220.2 and 382.3 mg O_2 L^{-1} which, according to the CONAGUA classification, are found within the category of heavily contaminated and, according to NOM-001-SEMARNAT, exceed the maximum permissible limits for use in agricultural irrigation (Figure 6).

According to the CONAGUA classification, the water used at station E2AP is for human use and consumption and is found within the acceptable category in the rainy season and in the contaminated category in the dry season. Although there is no NOM for potable water in relation to DBO_5, it is clear that these results correspond to the concentrations of fecal coliforms counted at each station in the two seasons of the year that were sampled (Figure 7).

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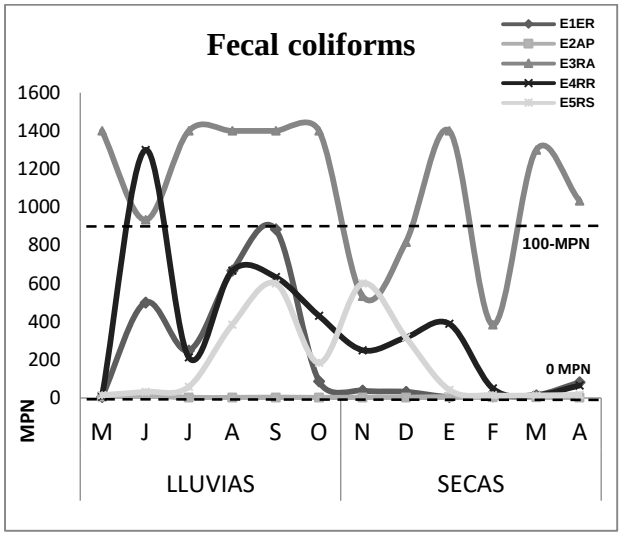

Figure 7 The values obtained for fecal coliforms in the rainy and dry seasons in each sampling station. NOM-001-SEMARNAT-1996 (1000 MPN/100 mL) NOM-127-SSA1-1994 (0 MPN/100 mL).

The average *E. coli* values in the Atoyac River watershed varied at an interval between 0.8 and 140E05 NMP/100 mL (Figure 7). The highest average values were observed at station E3RA across all the months of the year sampled. The high concentration of fecal coliforms is associated with the large quantity of organic material produced by discharge from nearby municipalities received by the Barranca del Águila, which coincides with that reported by Rodríguez, *et al* (2013). The lowest concentrations, 0.8 – 37.0 MPN/100 mL, were found at station E2EP, where the water is used as potable water. These values exceed the permissible limits under NOM-127 SSA1-1994 and indicate the presence of fecal contamination, highlighting the importance of disinfecting the water before use and consumption.

The average values at station E1ER oscillated between 4.3 and 883.3 MPN/1000 mL and were found to be within the maximum permissible limits for the discharge of contaminants into national waters under NOM-001-SEMARNAT-1996 (1000 MPN/100 mL).

However, they exceed the MPL under NOM-127 SSA1-1994.

Stations E4RR and E5RS are sites designed for recreational activities and, for all the months sampled, presented values that exceed the MPL under NOM-127 SSA1-1994, which means that bathers and those consuming fish are also at a high risk of contracting diseases. All the sites sampled on the river did not comply with the MPL under NOM-127 SSA1-1994 and are found to be contaminated (Figure 7).

These average values for *E. coli* coincide with the alterations to the chemical and physical parameters found when evaluating water quality, given that they are associated with organic contamination and are directly related to the concentration of *E. coli*.

Conclusions

This study concluded that, in accordance with the criteria established under NOM-001-SEMARNAT-1996, NOM-003-SEMARNAT-1997, NOM-127-SSA1-1994, the Federal Law - 2012, and CONAGUA - 2013, the river water used for human consumption is classified between acceptable and contaminated. Moreover, the water used in agricultural irrigation is highly contaminated and that used for recreation is found to be between highly contaminated and contaminated. Therefore, the water in the River Atoyac in the Tentzo microbasin is, in its current condition, not suitable for use by the inhabitants of the municipalities of Atoyatempan and Molcaxac.

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-Use Calibre Math typography (in equations), with subsequent numbering and alignment right: Example;

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-Should be self-explanatory (without resorting to text for understanding), not including abbreviations, clearly indicating the title and reference source with reference down with left alignment number 9 with bold typography.

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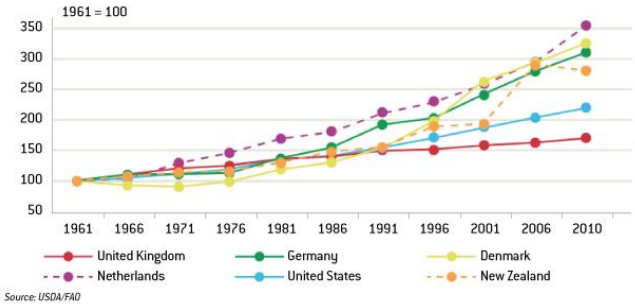

Graph 1 Agriculture Factor Productivity

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