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Research Article

Soil, Runoff Water Contaminated with Agrochemicals, their Relationship in Fruits (Passiflora ligularis) Oxapampa-Pasco

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Abstract

It was investigated in the district of Oxapampa, a place of high production of granadilla, where it was observed that farmers frequently use pesticides, they are protagonists of contaminating the soil, runoff water and that it is directly related to the quality of the fruit. The objective was to evaluate the relationship of soil and runoff water, in the concentration of heavy metals in fruits of (Passiflora ligularis), in the sectors; del Abra (Ab), Chacos (Ch), Quillazú (Qll), Acuzazú (Ac), Cañera (Ca), San Alberto (SA), Alto Río Pisco (ARP) and Paraíso (Pa). The Non-experimental and Correlative Design was used. The concentration correlation of As, Hg, Cd, Cu and Pb found in samples collected from soil and water from production fields of three groups (ABC) of farmers, as well as their relationship with the contamination of the fruits was determined. Whose results: Soil-Fruit: Determination index R 2 = (0.013 (As), 0.1348(Hg), 0.1189 (Pb), 0.0079 (Cd) and 0.1577 (Cu)). Runoff water- Fruit: R 2 = (0.109 (As), 0.1586 (Hg), 0.0005 (Pb), 0.0197 (Cd) and 0.0065 (Cu)); statistically it indicates that there is no linear correlation. interpreting for each unit in mg/Kg of each heavy metal that takes the independent variable of contaminated soil and water, there is an increase or decrease in the concentration of metals in the fruit, according to values of the angular coefficient in mg/Kg (As, Hg, Pb, Cd and Cu), according to Pearson, significance (α=0.05) was higher, accepting the null hypothesis, rejecting the alternative hypothesis. Conclusion: the concentrations of heavy metals found in the production fields do not statistically influence the concentration of metals in the fruits.

Introduction

In the rural sectors destined for agriculture, they are applying dangerous chemical inputs that are responsible for the concentration of heavy metals found in the soil, runoff water, the problem that afflicted at the time was to know what was the relationship of the soil and water of runoff in the concentration of heavy metals in the fruits of Passiflora ligularis due to the use of agrochemicals. In addition, it degrades the biotic and abiotic components of the production system, there is concern on the part of the rural population in the Oxapampa district, because they indicate that there is a history of crops that are very sensitive to heavy metals [1]. Bringing with it contamination in the field due to the effect of conventional agriculture, therefore the production of fruits with toxic residues of heavy metals and not only that, but also reduces production by other means where it alters the pollination of the flowers in a way negative. They report that passion fruit reached up to 34.3% fruit formation by spontaneous self-pollination, despite the intervention of an animated vector (Xylocopa spp.) significantly increased fruit formation (70%) [2]. This form of contamination is generating an alteration in the life of the plants, by inducing changes in the physiological process of the crop, modifications in the vital functions, for which it would be damaging the rates of primary production, generating little production of flowers and fruits, even more poor-quality fruits that will allow the farmer's income to decrease. Cd, Pb, Hg and as are toxic and can pose a great threat to plants, animals and humans [3]. Heavy metals, the toxicity they exert on different crops and their bioavailability, can be dangerous, added to the sensitivity of plants to the presence of metals and the tendency to accumulate. So, the concentration of heavy metals that is demonstrated in the soil and water in the study has a direct relationship in the quality of the fruits and an alteration in the functional development of the granadilla plants, which is affecting the use of pesticides with greater Frequently, by farmers in the effort of phytosanitary control, generating an environmental risk to humanity. The high concentration levels of heavy metals in irrigation water represent a significant problem for agriculture and human health, as well as for biodiversity [4]. There is great concern in the world about the environmental impact generated by this type of agriculture that is produced with agrochemicals that contain toxic heavy metals. The levels of heavy metals in agricultural soils and the incidence of soil characteristics in their concentration are factors that influence vegetables.

The contaminations found in agroecosystems are important proofs that show that the agricultural sector is conducting based on imprudent management practices, and that state institutions are not fulfilling their inspection functions in the field. To address this investigation, the following hypothesis was raised: " The heavy metal content of the soil and runoff water due to different intensity of agrochemical use, positively influences the concentration of heavy metals in Passiflora granadilla fruits. ligularis" and the objective was to determine the relationship of soil and runoff water, in the concentration of heavy metals in the fruits. The samples used were fruit, soil and runoff water analyzed in the Chemical Engineering laboratory of UNMSM Lima, the atomic absorption spectrophotometer analysis equipment was used. The result has allowed us to reflect on what happens in the rural sectors, according to the degree of statistical correlation of the determination index, with respect to the soil, runoff water, both in relation to the fruit contaminated with As, Hg, Pb, Cd and Cu by use. intensive use of agrochemicals, statistically there is no linear correlation. However, interpreting the values found for the angular coefficient indicates that for each unit in mg/Kg of heavy metals that the independent variable takes due to the contribution of contaminated soil, there is an increase in some cases and a decrease in the concentration of the aforementioned chemical components. in the passion fruit based on the values of the eel correlation coefficient. Therefore, it is concluded that the concentrations of heavy metals in the soil factor and runoff water from rainfall do not statistically influence the concentration of metals in the fruits.

Materials and Methods

Type

The work that was carried out, due to its purpose, is framed within the type of basic research, because it was analyzed what metallic elements the fruits contain, soil, runoff water; Obtaining social information to determine the cause of contamination under three dimensions of selected groups, according to the intensity of use of agrochemicals that the anthropic intervention is making and how it influences the contamination of the granadilla fruit due to the interaction of soil and water [5].

Population and sample

Population: The population was of the finite type that was made up of all the passion fruit cultivation fields (Passiflora ligularis) in full production in the Oxapampa district, with 1463 Ha.

Sample: The sample size consisted of 55 Ha of passion fruit in production, it was determined by the statistical formula:

$$n = \frac{Z^2pqN}{E^2(N-1)+Z^2pq}$$

Where Z = 1.65, P = 0.70, q = 0.30, N = 1463 and E = 0.10

From the 55 hectares of cultivation in full production of passion fruit, distributed among different owners with various extensions of cultivation of passion fruit, geographically they were distributed in the rural sectors within the district of Oxapampa, such as: Alto Rio Pisco, Cañera, Abra, Chacos, San Alberto, Acuzazú, Quillazú, Paraíso. The production fields were taken randomly in each sector, then a survey was carried out on each owner (farmer) through a questionnaire, information was collected on the surface of their passion fruit production fields, types of agrochemicals they generally use and with what frequently apply during the year of crop management. Then it was selected and grouped into three groups according to their intensity of application of agrochemicals per year; a group "A" those who apply with high frequency, in group "B" those who apply with medium frequency and a group "C" who apply with low frequency. From these groups, samples were taken in different sectors, already classified and duly coded for each production area; the sampling of fruits was random, taking 6 fruits/sample; In the same way, soil samples were extracted from the same field, also at random points, following a zigzag scheme at a depth of 20 cm from the arable layer, homogenizing the sub-samples and obtaining a single representative sample in an amount of 0.5 Kg; A sample of runoff water from the production fields was also taken in an amount of 1 liter/sample. For the latter case, it was necessary to previously prepare collectors (they are holes prepared on the surface of the ground, covered at the base or bottom with plastic to ensure accumulation of water by runoff on rainy days) at various points in the study area. The period of the extraction and transport of the samples from the field to the laboratory were 02 days, the water was collected in a white polyethylene bottle with a capacity of 1 liter as a representative sample, the fruit and soil samples were poured into Hermetic polyethylene bags for the appropriate capacity, later packed in cardboard boxes with holes on the sides for better ventilation and transportation over distance. All this criterion was taken on the recommendation of the specialist in the chemical analysis laboratory of the UNMSM - Lima, who were responsible for analyzing 15 fruit samples, 15 soil samples and 15 water samples, which corresponded to the entire dimension of land that I set the sample size.

Design of the investigation

Due to the nature of the research, the Non-experimental and Correlative Design was applied; defined as a schematic structure [5] states that in this design it determines the degree of relationship between two or more variables of interest in one or more samples, comparing the observations obtained and analyzing the inferences between two or more different populations, whose scheme is as follows (Figure 1):

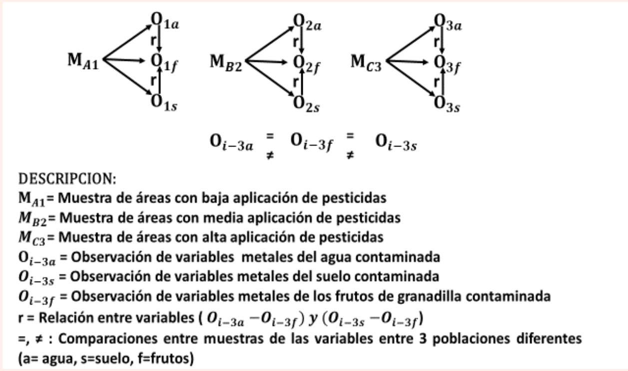

Figure 1: Comparing the observations obtained and analyzing the inferences between two or more different populations.

Data collection techniques and instruments

Data collection techniques: The techniques used during the investigation were: identification, observation, data collection and samples in the field and laboratory phase. For the social component, the interview and dialogue technique was used. For the evaluation of heavy metals (As, Pb, Hg, Cd and Cu) present in the samples, the protocol recommended by specialists from the Chemical Engineering laboratory of the Universidad Nacional Mayor de San Marcos de Lima was applied, using of the "Atomic Absorption Spectrophotometer", the results were measured in mg/Kg. For the 05 heavy metals under study.

Instruments

The instruments that were used in the investigation were: pre-designed formats, questionnaires, to record the data obtained during the evaluation process. In the same way, the questionnaire for the interview was validated with professionals and experts in research in the social area. Using the DELPHI method, which is a method of structuring a communication process, is effective when it comes to allowing a group of individuals, as a whole, to deal with a complex problem (Landeta, 1999).

Data processing techniques

The data obtained in the study area were processed in the office, SPSS and Excel software, descriptive and inferential statistics and Pearson's test were used from the processed data, analysis and interpretation, discussion and conclusions were made.

Results

Specific hypothesis

The content of heavy metals in the soil and runoff water due to different intensity of use of agrochemicals, positively influences the concentration of heavy metals in Passiflora granadilla fruits. ligularis in the Oxapampa district.

In relation to the content of the heavy metal of arsenic, mercury of the soil, in the concentration of the Passiflora granadilla fruit ligularis:

Ho: The content of As and Hg in the soil does NOT positively influence the concentration of As and Hg in the fruit. (There is no correlation)
H1: The content of As and Hg in the soil positively influences the concentration of As and Hg in the fruit (If there is a correlation).

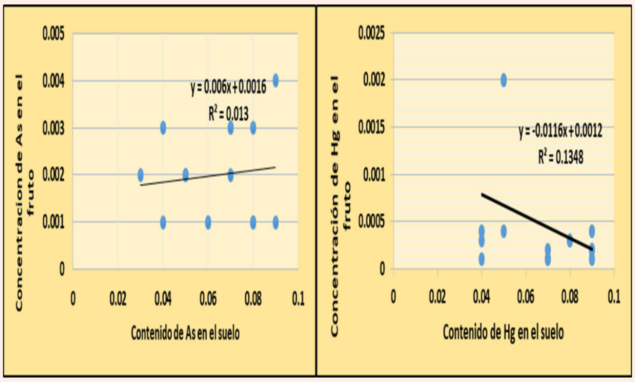

Figure 2: Scatter diagram of the influence of arsenic, mercury in the soil and its concentration in the fruits (mg/Kg).

There is the linear regression equation, where the concentration of heavy metals of arsenic, Mercury in the fruit "Y" corresponds to 0.006X+0.0016, 0.0116X+0.0012 both respectively, in addition the determination index R 2 is 0.013 and R 2 is 0.1348 according to the levels of statistical correlation, show that there is no linear correlation. However, the values obtained from the angular coefficient indicate that for each unit in mg/Kg of As and Hg that the independent variable takes due to the contribution of the contaminated soil, there is an increase in the concentration of heavy metals in the passion fruit. 0.006 mg/Kg of arsenic and 0.0116 mg/Kg of mercury (Figure 2).

Table 1: Pearson 's correlation test for the influence of arsenic, mercury in the soil and its concentration in the fruits (mg/Kg).

Ace		I usually		Fruit	
		Hg	Ace	Hg	
As and Hg ground	Pearson correlation	one	one	0.114	-0.367
	Next (bilateral)			0.686	0.178
	No.	fifteen	fifteen	fifteen	fifteen
As and Hg fruit	Pearson correlation	0.114	-0.367	one	one
	Next (bilateral)	0.686	0.178		
	No.	fifteen	fifteen	fifteen	fifteen

Source: Data obtained from the UNMSM Chemistry Laboratory, 2019.

When carrying out the population correlational hypothesis test according to Pearson, which is presented in (Table 1), the statistical decision is made to mention that the significance corresponds to 0.686 and 0.178, which are values greater than the significance of α = 0.05, a reason that indicates accepting the null hypothesis, and rejecting the alternate hypothesis, demonstrating that there is evidence to affirm that the content of arsenic and mercury in the soil does not positively influence the concentration of As and Hg in the fruit. Therefore, with certain relativity there is no correlation.

In relation to the content of the heavy metal of lead, cadmium of the soil, in the concentration of the Passiflora granadilla fruit ligularis:

Ho: The content of Pb and Cd in the soil does NOT positively influence the concentration of Pb and Cd in the fruit. (There is no correlation)
H1: The content of Pb and Cd in the soil positively influences the concentration of Pb and Cd in the fruit (If there is a correlation).

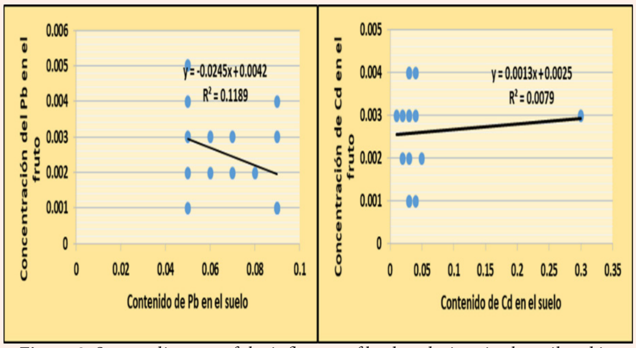

Figure 3: Scatter diagram of the influence of lead, cadmium in the soil and its concentration in the fruits (mg/Kg).

There is the linear regression equation, where the concentration of heavy metals of lead, cadmium in the fruit "Y" corresponds to 0.0245X+0.0042, 0.0013X+0.0025 both respectively, in addition the determination index R 2 is 0.1189 and R 2 is 0.0079 according to the levels of statistical correlation, they show that there is no linear correlation. However, the value obtained from the angular coefficient indicates that for each unit in mg/Kg of Pb that the independent variable takes, there is a tendency to decrease the concentration of the heavy metal in the passion fruit by 0.0245 mg/Kg of lead. In the case of Cd, there is an increase in the concentration of the heavy metal in the granadilla fruit of 0.0013 mg/Kg of cadmium (Figure 3).

Table 2: Pearson correlation test of influence of lead, cadmium in the soil and its concentration in the fruits (mg/Kg).

bp		I usually		Fruit	
		CD	bp	CD	
Pb and Cd soil	Pearson correlation	one	one	-,3. 4. 5	0.089
	Next (bilateral)			0.208	0.753
	No.	fifteen	fifteen	fifteen	fifteen
Pb and Cd fruit	Pearson correlation	-,3. 4. 5	0.089	one	one
	Next (bilateral)	0.208	0.753		
	No.	fifteen	fifteen	fifteen	fifteen

Source: Data obtained from the UNMSM Chemistry Laboratory, 2019.

When carrying out the population correlational hypothesis test according to Pearson, which is presented in Table 2, the statistical decision is made to mention that the significance corresponds to 0.208 and 0.753, which are values greater than the significance of α = 0.05, reason that indicates accepting the null hypothesis, and rejecting the alternative hypothesis, demonstrating that there is evidence to affirm that the content of lead and cadmium in the soil does not positively influence the concentration of Pb and Cd in the fruit. Therefore, with certain relativity there is no correlation.

In relation to the content of the heavy metal of copper of the soil, in the concentration of the Passiflora granadilla fruit ligularis:

Ho: The Cu content in the soil does NOT positively influence the Cu concentration in the fruit. (There is no correlation)
H1: The Cu content in the soil positively influences the Cu concentration in the fruit (If there is a correlation)

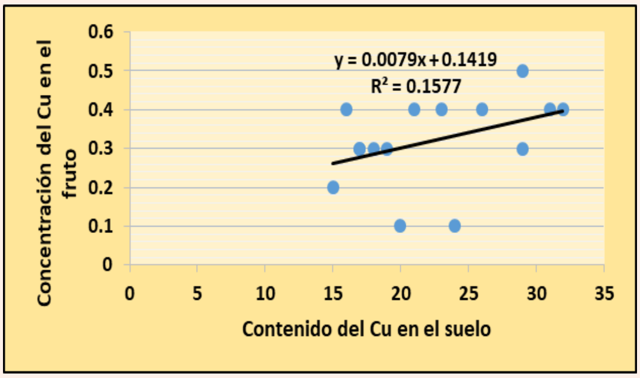

Figure 4: Scatter diagram of the influence of copper in the soil and its concentration in the fruits (mg/Kg).

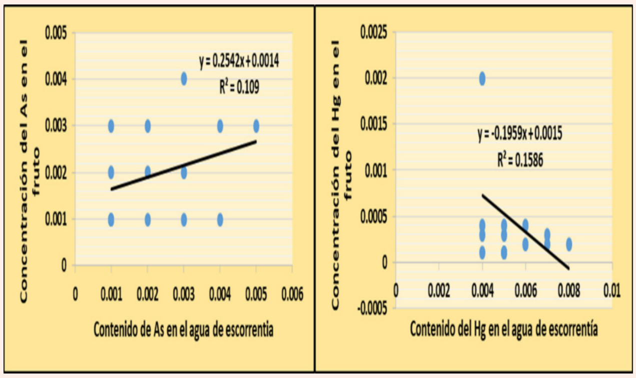

Figure 5: Scatter diagram of the influence of arsenic, mercury from runoff water and its concentration in the fruits (mg/Kg).

In Figure 4, there is the linear regression equation, where the concentration of the heavy metal of copper in the fruit "Y" corresponds to 0.0079X+0.1419, in addition the determination index R 2 is 0.1577 according to the levels of correlation statistics shows that there is no linear correlation. However, the value obtained from the angular coefficient indicates that for each unit in mg/Kg of Cu that the independent variable takes due to the contribution of the contaminated soil, there is an increase in the concentration of the heavy metal in the passion fruit fruit of 0.0079 mg/ kg of copper.

Table 3: Pearson correlation test of influence of soil copper and its concentration in fruits (mg/Kg).

		Cu on the ground	Cu in the fruit
Cu on the ground	Pearson correlation	one	0.397
	Next (bilateral)		0.143
	No.	fifteen	fifteen
Cu in the fruit	Pearson correlation	0.397	one
	Next (bilateral)	0.143	
	No.	fifteen	fifteen

Source: Data obtained from the UNMSM Chemistry Laboratory, 2019.

When carrying out the population correlational hypothesis test according to Pearson, which is presented in Table 3, the statistical decision is made to mention that the significance corresponds to 0.143, which is a value greater than the significance of α = 0.05, which is why which the null hypothesis is accepted, in the same way the alternative hypothesis is rejected, demonstrating that there is evidence to affirm that the copper content in the soil does not positively influence the concentration of copper in the fruit. Furthermore, with certain relativity there is no correlation.

In relation to the content of the heavy metal of arsenic, mercury of the runoff water, in the concentration of the Passiflora granadilla fruit ligularis:

Ho: The content of As and Hg in runoff water does not positively influence the concentration of As and Hg in the fruit. (There is no correlation)
H1: The content of As and Hg in the runoff water positively influences the concentration of As and Hg in the fruit (If there is a correlation)

There is the linear regression equation, where the concentration of the heavy metal of arsenic, mercury in the fruit "Y" corresponds to 0.2542X+0.0014, 0.1959X+ 0.0015 both respectively, in addition the determination index R 2 is 0.109 and R 2 is 0.1586 according to the levels of statistical correlation shows that there is no linear correlation for both. However, the value obtained from the angular coefficient indicates that for each unit in mg/Kg of as that the independent variable takes due to the contribution of contaminated runoff water, there is an increase in the concentration of the heavy metal in the passion fruit of 0.2542. mg/Kg of arsenic. In the case of Hg, the value obtained from the angular coefficient indicates that for each unit in mg/Kg of Hg that the independent variable takes, there is a tendency to decrease the concentration of the heavy metal in the passion fruit by 0.1959 mg/Kg of mercury (Figure 5).

Table 4: Pearson correlation test of influence of arsenic, mercury from runoff water and its concentration in the fruits (mg/Kg).

		Runoff water		Fruit	
Ace		Hg	Ace	Hg	
As and Hg water runoff	Pearson correlation	one	one	0.33	-0.398
	Next (bilateral)			,230	0.141
	No.	fifteen	fifteen	fifteen	fifteen
As and Hg fruit	Pearson correlation	0.33	-0.398	one	one
	Next (bilateral)	,230	0.141		
	No.	fifteen	fifteen	fifteen	fifteen

Source: Data obtained from the UNMSM Chemistry Laboratory, 2019.

When carrying out the population correlational hypothesis test according to Pearson, which is presented in [Table 4], the statistical decision is made to mention that the significance corresponds to 0.230 and 0.141, which are values greater than the significance of α = 0.05, a reason that indicates accepting the null hypothesis, and rejecting the alternative hypothesis, demonstrating that there is evidence to affirm that the content of arsenic and mercury in runoff water does not positively influence the concentration of As and Hg in the fruit. Therefore, with certain relativity there is no correlation.

In relation to the content of the heavy metal of lead, cadmium of the runoff water, in the concentration of the Passiflora granadilla fruit ligularis:

Ho: The content of Pb and Cd in runoff water does not positively influence the concentration of Pb and Cd in the fruit. (There is no correlation)
H1: The content of Pb and Cd in the runoff water positively influences the concentration of Pb and Cd in the fruit (If there is a correlation)

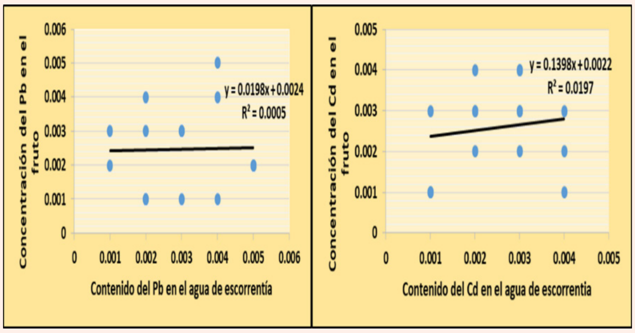

Figure 6: Scatter diagram of the influence of lead, cadmium in runoff water and its concentration in the fruits (mg/Kg).

There is the linear regression equation, where the concentration of the heavy metal of lead, cadmium in the fruit "Y" corresponds to 0.0198X+0.0024, 0.1398X+0.0022 both respectively, in addition it is found that the determination index R 2 is 0.0005 and R 2 is 0.0197 according to the statistical correlation levels, it shows that there is no linear correlation for both. However, the value obtained from the angular coefficient indicates that for each unit in mg/Kg of Pb and Cd that the independent variable takes due to the contribution of contaminated runoff water, there is an increase in the concentration of the heavy metal in the passion fruit. of 0.0198 mg/Kg of lead and 0.1398mg/Kg of cadmium (Figure 6).

Table 5: Pearson correlation test for the influence of lead, cadmium in runoff water and its concentration in the fruits (mg/Kg).

bp		Runoff Water		Fruit	
		CD	bp	CD	
Pb and Cd water runoff	Pearson correlation	one	one	0.022	,140
	Next (bilateral)			0.938	0.618
	No.	fifteen	fifteen	fifteen	fifteen
Pb and Cd fruit	Pearson correlation	0.022	,140	one	one
	Next (bilateral)	0.938	0.618		
	No.	fifteen	fifteen	fifteen	fifteen

Source: Data obtained from the UNMSM Chemistry Laboratory, 2019.

When carrying out the population correlational hypothesis test according to Pearson, which is presented in [Table 5], the statistical decision is made to mention that the significance corresponds to 0.938 and 0.618, which are values greater than the significance of $\alpha = 0.05$, a reason that indicates accepting the null hypothesis, and rejecting the alternative hypothesis, demonstrating that there is evidence to affirm that the content of lead and cadmium in runoff water does not positively influence the concentration of Pb and Cd in the fruit. Therefore, with certain relativity there is no correlation.

In relation to the content of the heavy metal of copper of the runoff water, in the concentration of the Passiflora granadilla fruit ligularis:

Ho: The Cu content in the runoff water does NOT positively influence the Cu concentration in the fruit. (There is no correlation)
H1: The Cu content in the runoff water positively influences the Cu concentration in the fruit (If there is a correlation)

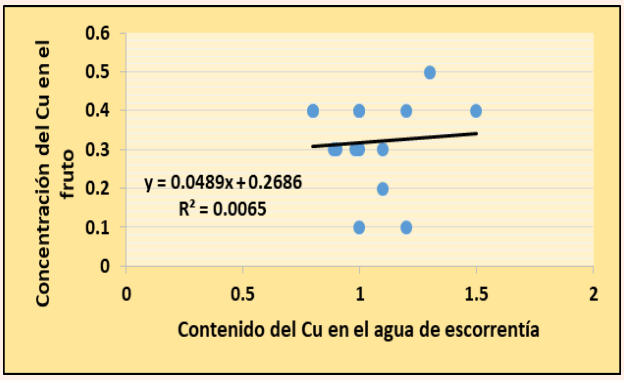

Figure 7: Scatter diagram of the influence of copper in runoff water and its concentration in the fruits (mg/Kg).

There is the linear regression equation, where the concentration of the heavy metal of copper in the fruit "Y" corresponds to 0.0489X+0.2686, in addition the determination index R 2 is 0.0065 according to the levels of sample statistical correlation that there is no linear correlation. However, the value obtained from the angular coefficient indicates that for each unit in mg/Kg of Cu that the independent variable takes due to the contribution of contaminated runoff water, there is an increase in the concentration of the heavy metal in the passion fruit of 0.0489. mg/Kg of copper (Figure 7).

Table 6: Pearson correlation test for the influence of copper in runoff water and its concentration in the fruits (mg/Kg).

		Copper in Runoff Water	Copper in the Fruit
Cu in runoff water	Pearson correlation	one	0.081
	Next (bilateral)		0.775
	No.	fifteen	fifteen
Cu in the fruit	Pearson correlation	0.081	one
	Next (bilateral)	0.775	
	No.	fifteen	fifteen

Source: Data obtained from the UNMSM Chemistry Laboratory, 2019.

When carrying out the population correlational hypothesis test according to Pearson, which is presented in [Table 6], the statistical decision is made to mention that the significance corresponds to 0.775, which is a value greater than the significance of $\alpha = 0.05$, which is why which the null hypothesis is accepted, in the same way the alternative hypothesis is rejected, demonstrating that there is evidence to affirm that the copper content in runoff water does not positively influence the concentration of copper in the fruit. It confirms that there is relatively no correlation.

Discussion

Correlation and regression of the concentration of heavy metals in passion fruit fruits due to the effect of soil and runoff water contaminated by the intensive use of agrochemicals in the production process in the district of Oxapampa. When determining the existing relationship between the heavy metals in the soil with respect to the effect of the fruits, it turned out that there is no correlation, performing the regression calculations also showed the existence that would not be positively influencing the concentration of heavy metals of arsenic, mercury , lead, cadmium and copper in the passion fruit fruits, also interpreting the regression equation, there would be an increase in the concentration of heavy metals (As, Cd and Cu) in the dependent variable, according to the positive values of the angular coefficients. The availability of an increase could occur according to the interaction with the plants, in this regard [6], when mentioning that one of the main problems presented by heavy metals is that there are not too many metabolic routes by living beings and that they have a limited capacity, which is why it is linked to an excessive contribution to the environment, generally of anthropogenic origin, it generates serious environmental problems. In other cases, according to the values of the negative angular coefficient, it reveals the existence of a tendency to decrease the concentration of heavy metals (Hg, Pb) in the dependent variable; the latter probably due to a phytotoxicity effect on the plants, a physiological alteration which decreases the movement of the heavy metal; corroborates by pointing out that the high levels of heavy metals such as lead, nickel, cadmium and manganese, present in soils and water, used for agricultural irrigation, mainly lie in the fact that they can be accumulated in the system (plant) by Their non-biodegradable and toxic characteristics that they exert on different crops and their bioavailability can be highly dangerous. When determining the existing relationship between the heavy metals in runoff water with respect to the effect of the fruits, it turned out that there is no correlation, performing the regression calculations also showed the existence that would not be positively influencing the concentration of arsenic heavy metals , mercury, lead, cadmium and copper in the passion fruit fruits, in addition to interpreting the regression equation, there would be an increase in the concentration of heavy metals (As, Hg, Pb, Cd, Cu) in the dependent variable, according to the positive values of the angular coefficients; affirms [7] when showing a research result that are the accumulations of low and highest heavy metals measured in fruits and were the following; cadmium (0.17-0.40 mg/g dry wt), copper (7.67-14.27 mg/g ps), and lead (4.31-5.51 mg/g dw).

The relative abundance of heavy metals in tomato samples were observed as copper gt; lead > cadmium gt. in other cases, according to the values of the negative angular coefficient, it reveals the existence of a tendency to decrease the concentration of heavy metal (Hg) in the dependent variable. Maintaining that contaminated water is a way that contributes to the phytotoxicity of plants, which alters the physiological and phenological process of the crop in this case of passion fruit; in this regard [8] mentions that pesticides are washed away by runoff water from crop fields, contaminates the food chain system causing the death of various forms of life in the ecosystems. Through the regression and correlation calculation, it has been determined how two dependent and independent variables are related, such as the concentration of heavy metals in the fruits, having determined values that indicate that for each unit in mg/Kg that the independent variable takes, open an increase in the concentration of toxic heavy metals in relation to the passion fruit respectively. In this regard, it corroborates (by mentioning that a relationship occurs when one of the variables influences the other, as well as the relationship of two variables can be the degree of correlation between them and observe the different concentration levels of the metals studied [9-13].

Conclusion

According to the dispersion diagram and the Pearson correlation test, there is no correlation in the soil-fruit and runoff water-fruit relationship, with the determination of the linear regression equation for the soil-fruit case, an increase in the concentration of the heavy metal in the granadilla fruit of 0.006 mg/Kg of arsenic; of 0.0013 mg/Kg of cadmium and 0.0079 mg/Kg of copper. Tendency to decrease in the concentration of heavy metal in the fruit of 0.0116 mg/Kg of mercury, 0.0245 mg/Kg of lead. In the case of runoff-fruit water, an increase in the concentration of the heavy metal in the passion fruit fruit of 0.2542 mg/Kg of arsenic is presumed; of 0.0198 mg/Kg of lead, 0.1398 mg/Kg of cadmium and 0.0489 mg/Kg of copper. Tendency to decrease in the concentration of the heavy metal in the fruit of 0.1959 mg/Kg of mercury.

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