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Characterization and Modifications in Watermelons (*Citrullus Lanatus*) cv Fashion, after the Application of Saline Waters

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Abstract

Quality and characteristics of watermelon (cv. Fashion) were studied and compared with different salinity conditions (ah cultivated in greenhouses with Mediterranean climate). Different parameters were measured during the culture, after the harvesting: temperature and humidity during the culture, weight and dimensions of fruits, pH value, total soluble solids (°Brix), water, ash and metal content present in the pulp. In any case, fruits exceeded quality parameters required by the legislation concerning this culture.

Keywords: watermelon, fashion, properties, greenhouse, salinity.

Introduction

Watermelon is thought to have originated in Southern Africa because it is found growing wild throughout the area, and reaches maximum diversity of forms there. It has been cultivated in Africa for over 4,000 years **[1].**

Nowadays, it is shown a noticeable increase in watermelon production and, according to recent data available from the **[2],** it reaches its peak level in year 2008. This is due to its expansion and, therefore, an increase in the area under cultivation (**figure 1**). All of this reinforces the importance in growing this fruit in Spain.

The present work focused on the investigation of the capability of dried biomass of Spirogyra hyalina to remove heavy metal from aqueous solution at different initial concentrations of the heavy metals and at different exposure period of dry biomass.

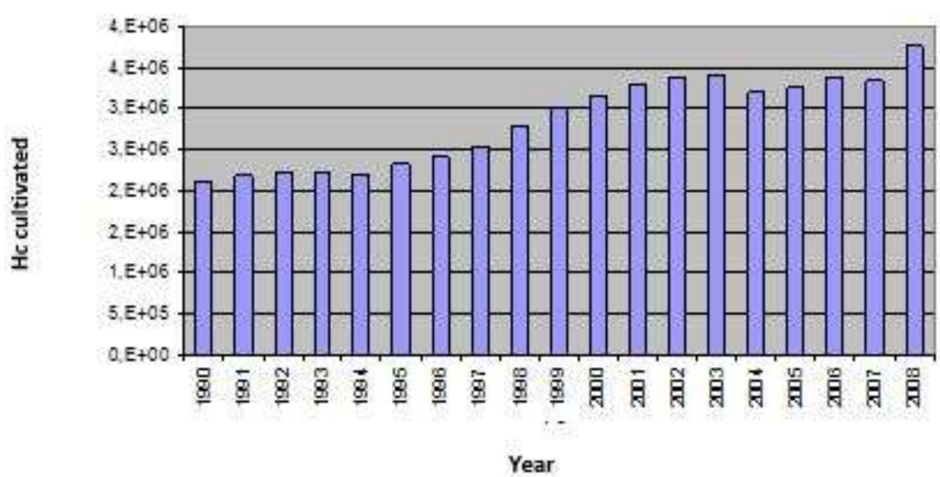

Figure 1. Evolution of the global cultivated watermelon area.

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The main watermelon producers in the world still are some of the main countries which cultivate this fruit in Europe as Spain, Italy or Greece, as well as China, Japan and Turkey **[3].**

Due to the great variety of existent seeds, they can be classified as diploids (with seeds) or triploids (without seeds), also called "apirenas" **[4].** Given that the latter are the most relevant types of the recent varieties, the study is focused in one of them, the variety Fashion. It is triploid (seedless), similar in appearance to the traditional watermelon. Dark green almost black, slightly pink flesh with high content in water, good flavour, great resistance and good conservation; for three/four years now that it is in the market, competes with the varieties Sugar Baby and Resistent **[5].**

The A.G.F (Association Group Fashion) is the owner of the brand Fashion (Horticom). It will be compulsory that the vegetal material comes from authorized seedbeds by the association **[6]**.

It will be compulsory, in order to commercialize with the denomination of Watermelon "Fashion, seedless taste", the use of the variety Fashion F1 of Nunhems, using pollinators appeared in the standard. The selected pollinator for the experiment is the variety Jenny (**figure 2**).

Figure 2. Sandía Fashion y polinizador Jenny

The refractometric index of the pulp measured at the middle point of the fruit flesh at the equatorial section must be greater than or equal to 10 °Brix **[7].** The minimum weight is fixed at 2kg.

Numerous studies were carried out to evaluate the effect of salinity on plants. Interesting results on the salinity influence were obtained from the study on the wild oat at Iran **[8]**. In Spain, the University of Almería also carried out studies on the salinity influence on the cultivated tomato in greenhouse under Mediterranean climate conditions **[9].**

The term "saline" is applied to soils whose conductivity of the saturation extract is greater than 4 mmhos/cm (1 mmhos/cm = 1 dS/m) at 25°C. These types of soils are almost always identified by the presence of white salt crusts on the surface (white death). Chemical characteristics of the saline soils are mainly determined by the type and quantity of salts. Sodium rarely represents more than half of the total soluble cations and, therefore, it is not significantly absorbed. Relative quantities of calcium and magnesium present in the soil solution and in the exchange complex vary considerably. The chief anions are chloride, sulphate and sometimes nitrate **[10].**

Salinity or "white death" is a severe agricultural problem in many parts of the world and will be a relevant topic along the actual millennium. Therefore, a suitable water supply for irrigation is important for the agricultural production. However, the good quality water resources do not satisfy the growing demand. Nowadays, the groundwater is the greater water resource, but 55% is saline. Na and C1 are the most abundant ions. In coastal regions, there are marine intrusion risks, such is the case of the coast, where NaC1 is the main responsible of conductivity increase. Na_2SO_4 also increases conductivity, and it is likely to be present in groundwater of arid and semi-arid zones **[11].**

Objectives

Given the importance that the fruit and vegetable production has acquired in the south-eastern of Spain, and specifically in the provinces of Almería, Granada, Málaga and Murcia among others, we have decided to carry out a series of studies in greenhouses of forced fruit productions in the West Almería, related with previous works of **[12]** on production of melon Galia at greenhouses in Almería.

Following these studies, we carried out experiments in watermelon crops variety Fashion,

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under growing conditions of the Mediterranean coast of Almeria and different saline conditions of the soil.

They were evaluated: climate conditions of the greenhouse (temperature and humidity) fruit dimensions and weight, sweetness (° Brix), acidity and basicity (pH), water and ash content and analysis of metals in the pulp.

Different dissolutions of three salts NaC1, Na_2SO_4 and $MgS0_4$ were tested. These are the most frequent salts in soil at the semi-arid zones and result of the marine intrusion in aquifers, or drift of maritime areas closer to the culture places. This way, the effect in the obtained fruits for its commercialization is seen.

To sum up, the study wants to show if, under the concentration values (and, therefore, the conductivity) of the dissolutions added to the soil, it can be determined differences in the final development and characteristics of the cultivated watermelon Fashion.

Material and Methods

Experiment was carried out in an area for the cultivation of watermelons, so this can be representative. General info about the experiment plot is the following: Estate: Rustic; Province: Almería; Municipality: El Ejido; Range: 22; Plot: 16; Greenhouse: 2; Greenhouse's surface: 9,800 m2.

The greenhouse of sloping roof design corresponds with a gabled greenhouse. The greenhouse has passive side ventilation **[12].**

Watermelons of variety Fashion were cultivated, using as pollinators the variety Jenny. Number of cultivated plants: 1,265 Fashion and 419 Jenny. Crop distribution was appropriate for good staggered pollination.

In order to record humidity and temperature values under growing conditions it was used a weather station MSR 145.

12 plants of the watermelon Fashion were taken, in which different dissolutions were added, with 3 or failing that 2 fruits per plant. In only one row, the distribution in **figure 3** was done and dissolutions in **table 1** were added.

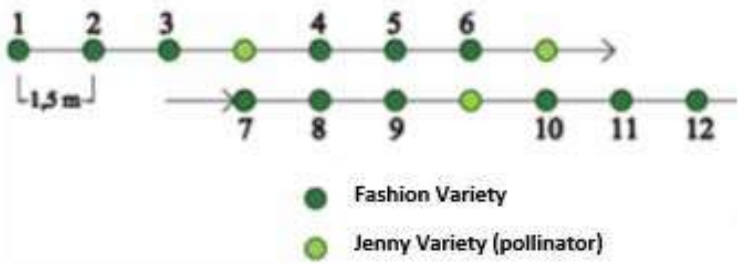

Figure 3. Sample distribution

Table 1. Sample treatment.

Nº MUESTRA	TRATAMIENTO
1	NaCl 0,1 %
2	NaCl 0,3 %
3	NaCl 0,5 %
4	Control
5	$Na_2(SO_4)$ 0,1 %
6	$Na_2(SO_4)$ 0,3 %
7	$Na_2(SO_4)$ 0,5 %
8	Control
9	$Mg(SO_4)$ 0,1 %
10	$Mg(SO_4)$ 0,3 %
11	$Mg(SO_4)$ 0,5 %
12	Control

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The addition of dissolutions was done using PET bottles and ceramic irrigation dispensers. These withdraw the dissolution according to the needs and soil humidity.

Each fruit was marked with a belt, noting the sample number to what they belong. Later, dissolutions are poured from the bottles. Finally, for the collection of samples, independent plastic bags were used, marking them appropriately to avoid confusions.

The analysis of pH, total soluble solids (°Brix), water and ash content and metal content were carried out following the "Métodos Oficiales de Análisis de los Alimentos" **[13].**

For all analysis carried out, it is necessary first create the purées through crushed pulp. To make it suitable for tests, carbon dioxide is extracted through agitation and vacuum for 10 minutes.

Results

Growing conditions regarding humidity and temperature are shown in **figure 4**. It was reached a maximum T value of 47.9°C and minimum of 11.2°C. Regarding humidity, it was reached a maximum value of 98.9% and minimum of 19.5%.

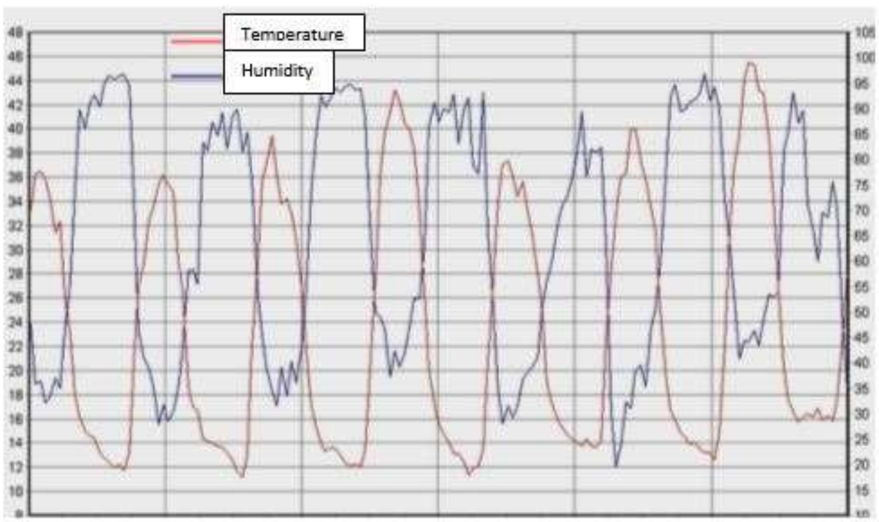

Figure 4. Climate conditions

An evolution control on the diameter of watermelons was carried out during the time in which the treatment was applied. The weight was measured at the beginning and at the end of the experiment (**table 2**). Final weights of watermelons vary and have an average value of about 7.2 kg. Final diameters have an average value of 23.3 cm.

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Table 2. Fruits weight and diameter

Sample	First Weight(g)	Final Weight(g)	Diameter 1 (mm)	Diameter 2 (mm)	Diameter 3 (mm)	Diameter 4 (mm)
1.1.	3.700	8.120	118,50	208,13	237,38	248,20
1.2.	2.871	9.170	114,65	222,14	249,30	256,90
1.3.	2.892	7.610	166,50	202,76	227,70	232,40
2.1.	2.874	6.950	176,29	209,00	221,48	233,30
2.2.	1.870	5.600	149,13	188,88	211,00	219,60
2.3.	2.187	6.825	182,57	201,44	224,40	223,90
3.1.	3.265	6.225	181,20	205,10	222,05	226,10
3.2.	2.985	7.425	176,94	200,92	219,24	236,40
3.3.	4.715	8.125	205,94	219,18	237,60	237,70
4.1.	3.530	7.520	183,98	210,16	277,25	233,80
4.2.	>5000	8.730	200,65	226,39	239,37	247,80
4.3.	2.292	6.450	163,37	192,61	214,42	230,40
5.1.	3.770	6.000	186,22	203,25	219,54	220,00
5.2.	2.631	5.705	165,97	190,90	213,49	215,10
6.1.	3.856	8.180	196,12	218,65	233,17	238,70
6.2.	4.043	8.970	201,99	225,16	238,60	250,00
6.3.	3.887	7.750	195,76	213,27	235,40	227,90
7.1.	3.717	7.770	188,56	217,48	230,65	247,40
7.2.	4.775	8.560	209,32	222,45	245,50	248,20
8.1.	4.431	8.420	201,36	222,66	237,50	241,70
8.2.	3.907	7.735	191,90	213,18	234,90	237,90
8.3.	3.888	7.250	192,18	217,63	228,58	235,00
9.2.	2.800	5.090	172,05	184,73	207,69	214,20
9.3.	3.345	8.220	193,85	220,66	241,10	244,60
10.1.	4.485	9.950	203,04	233,32	254,66	260,00
10.2.	4.590	9.760	198,66	228,59	247,40	255,70
10.3.	4.600	9.580	203,16	217,86	236,70	249,20
11.1.	2.988	6.860	178,11	200,55	226,20	232,30
11.2.	3.950	6.400	176,72	195,65	210,55	223,10
11.3.	1.469	6.725	151,97	183,32	215,89	227,60
12.1.	2.480	4.560	157,21	168,28	182,00	200,10
12.2.	1.330	4.890	145,55	185,02	200,58	224,00
12.3.	2.230	3.555	162,50	169,00	172,12	191,80

Results of °Brix, pH, humidity and ashes are shown in **table 3**. Sugars of watermelons are kept in general above 10°Brix. Regarding the pH, values around 5 were obtained. Water content of the watermelons is inside the reference values of the bibliography, between 88 and 92%. Ashes are kept in an average value of 0.5% approx.

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Table 3. ºBrix, pH, humidity and ashes content

Samples	ºBrix	pH	% Humidity	% ashes
1.1	12,3	4,79	89,77	0,7369
1.2	11,8	4,09	90,45	0,6202
1.3	11,5	4,75	90,24	0,5684
2.1	11,3	5,16	90,56	0,5223
2.2	9,5	4,05	92,29	0,4859
2.3	10,1	4,03	91,53	0,5365
3.1	11,0	4,22	90,68	0,5611
3.2	11,3	4,63	90,73	0,6296
3.3	11,0	6,07	89,67	0,4966
4.1	12,0	5,79	89,71	0,5536
4.2	12,7	5,61	88,94	0,5822
4.3	11,8	5,07	91,29	0,4830
5.1	10,1	4,11	92,23	0,4699
5.2	11,3	4,63	90,81	0,6249
6.1	11,0	5,80	90,74	0,6118
6.2	11,5	6,90	90,04	0,4901
6.3	11,4	5,90	89,44	0,6410
7.1	11,5	5,86	90,59	0,1292
7.2	11,2	4,78	89,67	0,5321
8.1	11,0	6,03	90,75	0,6344
8.2	11,1	4,72	90,10	0,5744
8.3	11,5	5,00	90,29	0,4549
9.2	8,7	4,20	93,46	0,3746
9.3	9,3	4,24	91,90	0,5118
10.1	11,5	5,25	90,45	0,4941
10.2	9,9	4,16	91,86	0,8726
10.3	12,0	6,03	88,71	0,6367
11.1	11,2	4,77	90,93	0,6192
11.2	9,6	4,38	91,56	0,4988
11.3	10,4	5,59	91,40	0,4963
12.1	10,0	4,08	92,08	0,5746
12.2	11,0	4,04	90,93	0,6380
12.3	9,2	4,24	92,53	0,4205

The analyzed metals from ashes were sodium, magnesium, calcium, copper, iron, manganese, zinc and potassium. From all of them, only in sodium there were obtained values considerably different from some salt treatments to others (**figure 5**).

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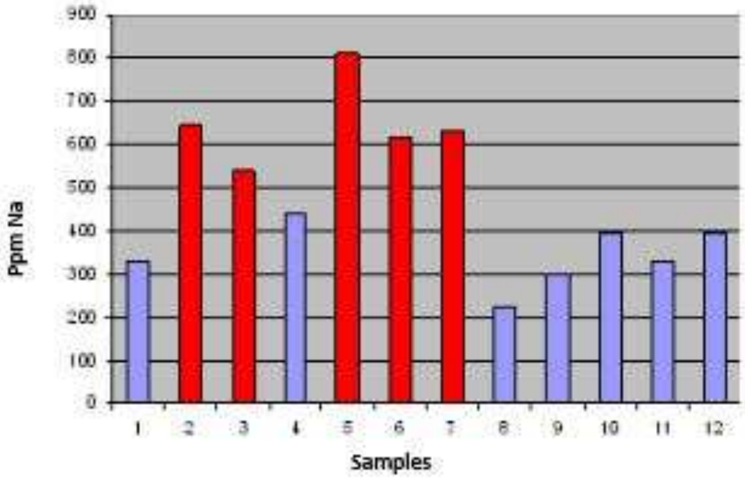

Figure 5. Sodium average content in the ashes.

Carrying out a statistic treatment of data, interesting correlations were found. **Figure 6** shows a negative correlation between °Brix and water content.

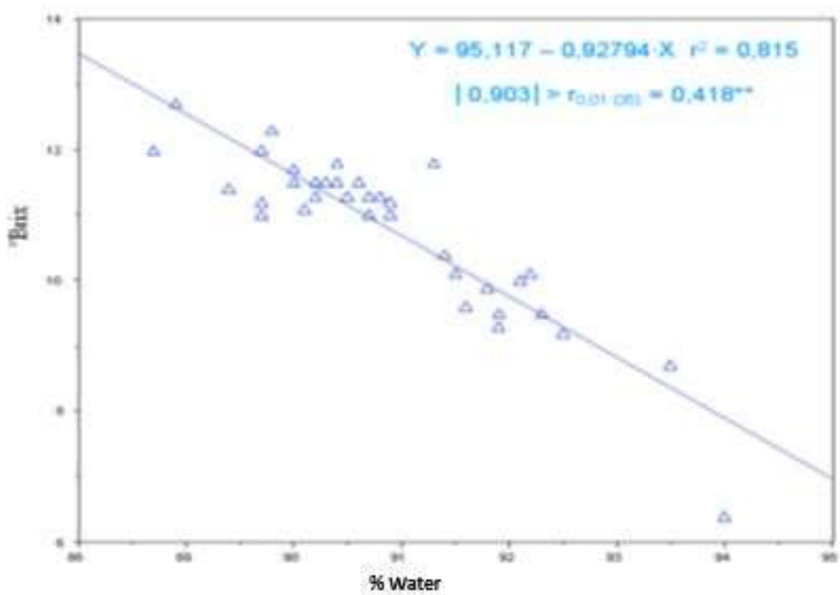

Figure 6. Correlation between ºBrix and water content.

Figure 7 shows a correlation between the initial weight (curdled fruits once they are extracted from the hive and at least 1 kg) and the final weight (in the recollection). **Figure 8**, correlation between water content in the pulp and its pH is represented.

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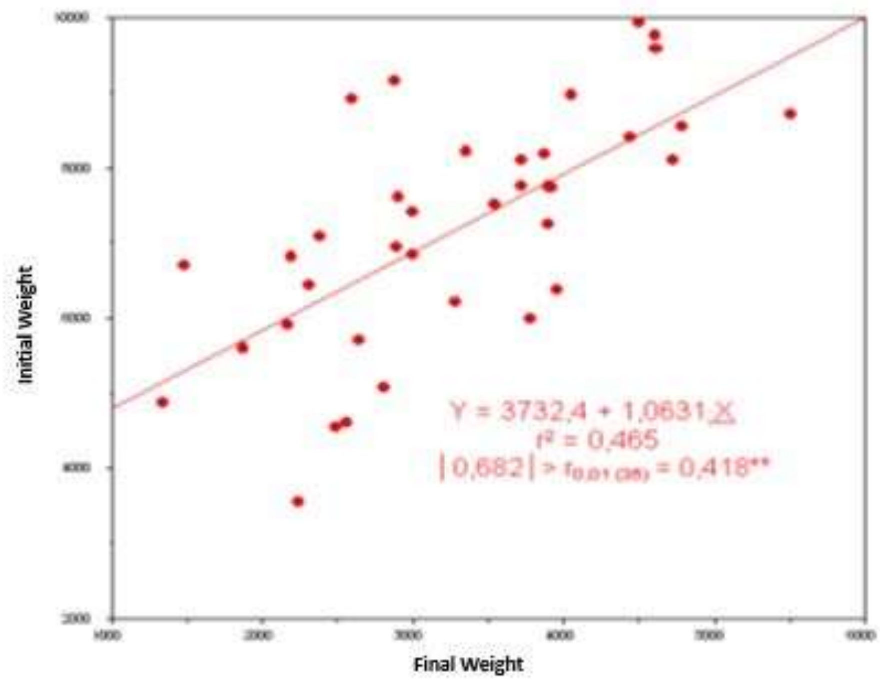

Figure 7. Correlation between final and initial weight

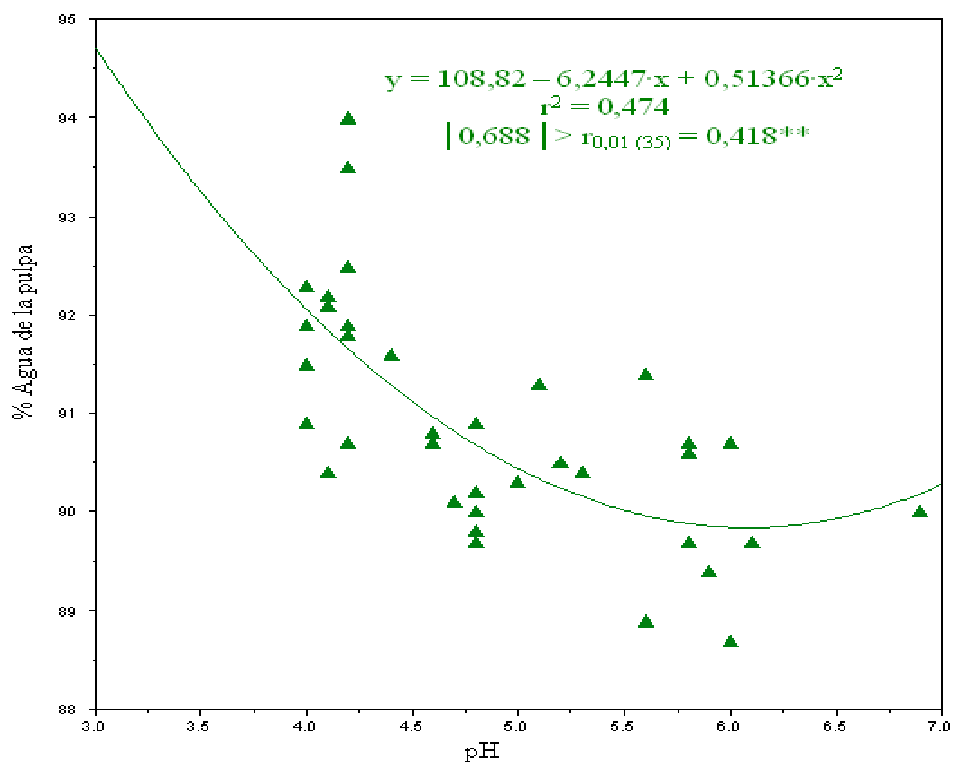

Figure 8. Correlation between water content and pH

Discussion

During the first 10 days, temperature surpassed 40°C only 2 times; the remaining days, in daytime, 40°C were surpassed, until 47.9°C max. In the night, temperature was kept around 20°C approx. reaching 11.2°C mm. Temperature and humidity (**figure 4**) follow reverse cycles, so higher humidity was found during the night and the lower one during the day.

Both the diameter and the weight of the watermelon are experienced an important increase during the experimentation Study has been carried out during the development stage, just after extracting the hives from the greenhouse. Final average weight of the fruits is 7.2 kg although it has been reached values of 9.95 kg. Obviously, diameter is proportional to weight, and it has been reached values of 26 cm although average value is 23.3 cm.

Average sweetness of watermelons, expressed as °Brix, has a value of 10.5°Brix and therefore has surpassed the value of 1 0°Brix necessary for the commercialization of the watermelon type Fashion, according to RCSF (Regulation on Quality of the Watermelon Fashion).

Average pH of the purées was 4.88, value close to 5, which is the common one given in the bibliography. Values range from 4 to 6.9.

Average humidity of the fruits is 90.88%, value also close to 91.5%, given in the bibliography. Moreover, values do not have a very high dispersion, ranging from 88.71% to
94.02%.

Ashes have a higher value in this case study, with an average value of 0.57%.

The analysis of metals, except for the sodium, does not provide values which can be concretely related with the type of treatment carried out on each plant.

In **figure 6**, there is a negative correlation between °Brix and water content of linear type, whereas the water content in the watermelon increases, the °Brix value diminishes. This can be explained using a possible dissolution of sugars in the fi-uit as the water content increases.

In **figure 7** show the correlation between the initial weight (curdled fruits once they are extracted from the hive and at least 1 kg) and the final weight (in the recollection), so this way, final weight of watermelons can be estimated from the initial weight values, recreating similar growing conditions.

In **figure 8**, a phenomenon similar to this of the sugars appears, whereas the humidity increases, the dilution of the present acids happens (increase of pH).

Finally, in the case of the analysis of sodium, it was clearly shown that, in 5 out of 6 plants where the added salt had Na+, levels of this metal in the ashes of the watermelon surpassed 500 ppm. Plants 1, 2, 3, 5, 6 and 7 were those in which the added solution had sodium. Only in plant n°1, where concentration of the added NaC1 was the smallest one (0.1%), average content in Na^+ of ashes did not reach 500. However, in the remaining plants, content had been clearly higher, showing an influence of soil salination on the composition of the watermelon type Fashion.

Conclusions

In the concentration range of the used treatments, there is a visible influence on the development and growing of the watermelon type Fashion.

The sweetness of watermelons, measured as °Brix, has a higher value to the one required by the standard (10°Brix, RCSF 2/09), however there is no significant variation of the °Brix between the different treatments of salt addition.

Water content of watermelons has a negative correlation with the value of the °Brix corresponding with 1%.

Value of: % ashes, pH, % water does not suffer significant changes with the different treatments carried out, and in the salt concentration ranges which are added.

So, the presence of an influence in treatments can not be deduced from the concentration value of metals in ashes, except form the sodium.

Sodium provides relevant results regarding its ash concentration for the different treatments. It only appears in concentrations higher than 500 ppm in 5 plants, precisely five out of the six to which it has been administered sodium. So, the significant fact of, even with values of soil salination lower to the present in sea water, there is an important increase of the sodium concentration in the watermelon.

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