THESIS
on

COMPOSITION OF THE HOP (HUMULUS LUPUS) WITH REFERENCE TO ITS PLANT FOOD CONTENT.

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COMPOSITION OF THE HOP (HUMULUS LUPUS) WITH REFERENCE TO ITS PLANT FOOD CONTENT.

Little is known of the history of the hop earlier than the ninth Century. While it is known that the wild hop grew in Western Asia and Southern Europe before this time, yet nothing is known of the first cultivation of the plant. Although this plant grew uncultivated and under a different name it is known to have been the same plant as the hop of today. In his Natural History Pliny describes Lupus Salictarius (the wild hop) as a sacred plant cultivated in the garden of the King. It was supposed to possess great powers as a healing herb. Today the hop is most valuable in its commercial application for brewing purposes. Its value in the medical field has however long been known; at the present time it enters into many medicinal remedies.

A study of the soil best adapted for the hop has shown that the rich sandy soil of the river bottom gave the best results. In his investigations of the California soil as fitted for hop culture, Hillgard makes favorble reports on two kinds. One the low sandy soil of the river bottom, which is rich in all ofthe plant foods, and especially in organic nitrogen; the other a table land which has loose soil to the depth of several feet, thus giving the long roots a chance to develop and gather an abundance of plant foods necessary for the development of the plants.

It shall be the object here to study the hop in relation to its plant food content and determine the draught of these from the soil. A study of a plant has shown that approximately fourteen of the elements of the soil enter into its composition. The average soil is however abundantly supplied with all of these elements, excepting four, which are therefore the basis of all fertilizers and are so called critical elements namely: nitrogen, potassium, phosphorous, and calcium.

The elements of the soil exists in complex compounds which are only slightly soluble in the soil moisture, a wise provision, which prevents the heavy rainfalls from leaching out the food necessary for the life of the plant. The insolubility is overcome by means of a sap sent out by the rootlets for the purpose of collecting food for the plant.

<u>A STUDY OF THE PLANT FOODS</u>

Nitrogen may exist in the soil in various forms as: organic N, Free Ammonia, Nitrates or Nitrites. As Free Ammonia the ~~organic~~ Nitrogen is taken up by the leguminous plants. These plants are supplied with small tubercles. The bacteria which live therein cause the nitrogen to be changed to nitrate which may be assinilated by the plant. The nitrates are formed by the complete oxidation of organic matter. Decaying organic matter is not assimilated by the plant until complete oxidation has taken place.

Potash exists in the soil in the form of silicates: these silicates are of two kinds, hydrous and anhydrous. Anhydrous silicates are almost wholly insoluble, while the hydrous silicates are slightly soluble in the soil moisture and readily soluble in the root sap. Potash also exists in organic combination in humus.

Phosphorous exists in combination with the elements iron, aluminum,. calcium, and magnesium. The phosphates of calcium and magnesium are more available to the plant than those of iron and aluminum. Besides these inorganic compounds, a certain amount of phosphorous is known to exist in organic combination with the humus of the soil.

Calcium which is known to us as lime exists in the soil in the form of carbonates and phosphates. These compounds undergo slow decomposition by the action of the carbonic acid of the soil, thus rendering them available to the plant.

METHODS USED IN THE DETERMINATIONS.

Samples of the cones, leaves and stalks were first weighed then dried in the water bath until free from moisture. From the two weights the amount of moisture in the plant was determined. A known amount of each sample was then ignited first at a low heat, then over a blast lamp until free from organic matter. The ash contained the mineral elements of plant food. These were dissolved by means of hot water and a small amount of hydrochloric acid. The insoluble silicates were ignited and weighed. The solutions containing the non-volatile plant foods were then made up to definite volumes. Of these solutions aliquot portions representing known amounts were taken for analysis. The official method were used in the determinations.

THE NITROGEN was determined by the Gunning method. A weighed amount of the sample was digested in a Kjeldol flask in the presence of concentrated sulphuric acid and potassium sulphate until all of the organic matter was destroyed and the solution was clear. The sulphuric acid solution was then washed into a distilling flask. The solution was made alkaline by the addition of sodium hydroxids. This released the ammonia which was distilled over by heating. The distillate was collected in a known amount of hydrochloric acid and the excess of acid titrated with n/10 ammonia.

FOR POTASH ---aliquots representing one gram were evaporated in platinum crucibles with one cubic centimeter of 50% sulphuric acid. The residue was then ignited to destroy all organic matter. The residue was then taken up with water and a few drops of hydrochloric acid. To this solution enough platinum chloride solution was added to convert the potash into potassium platinic chlorid. This was placed on a water bath and evaporated to almost dryness. The potassium platinac chlorid was first washed in 95% alcohol, then transferred to an asbestos gooch filter and washed with a solution of ammonium chlorid. The gooch and precipitate were dried at 100 degrees C and weighed. The precipitate was then dissolved out by the addition of boiling water and the gooche again dried and weighed. The difference in weights represented the weight of potassium platinic chlorid. From this theamount of potash (K 20) was calculated, using the factor.1942.

The PHOSPHORIC ACID Was determined by Pemberton's method.

Aliquots corresponding to one gram of the material were taken. The solutions were made alkaline by the addition of ammonia. Then enough nitric acid was added to the hot solution to just neutralize. It was then heated to a temperature of about 65 degrees C. The ammonium molybdate was then added. After standing at this temperature for fifteen minutes, the yellow precipitate was transferred to a gooch filter and washed free from acid. The precipitate of ammonium phospho molybdate was then transferred to a casserole and dissolved in a measured amount of standard sodium hydroxide. The excess of alkali was titrated with standard nitric acid phenolphthalein was used as an indicator.

The CALCIUM was determined with more difficulty than other elements. It was found by experiment that in separating out the iron, aluminum and phosphoric acid that a certain amount of calcium came down in the form of a phosphate. This was due to the excess of phosphoric acid, and the small amount of iron and aluminum present. Experiments showed that on adding an excess of iron solution that the calcium was left in the solution. The precipitate was then washed and transferred to a filter and again washed until free from chlorids. This gave a large volume of the filtrate which was evaporated to a volume of not more than 100 c.c. To the hot solution was added ammonia and ammonium chloride. The calcium was then converted into an oxalate by the addition of ammonium oxalate. The precipitate was allowed to stand for an hour and filtered. The calcium oxalate was then ignited over the Bunsen Burner and weighed as calcium oxid (CaO).

The results of analysis on the moisture free material are as follows:

Low land hops	Cones %	Leaves %	Stems %	Highland Hops Cones %	Other low Land Hops Cones %
Nitrogen	1.88	1.15	.56	1.96	1.84
	1.82	1.17	.52	1.96	1.82
Potash	.99	.79	.71	1.13	1.23
	.98	.74	.71	1.12	1.20
Phosphoric	1.08	.49	.31	1.13	.80
Acid. (P2O5)	1.09	.49	.30	1.10	.80
Lime (CAO)	1.20	4.52	1.46	1.33	1.25
---	1.25	4.52	148	1.30	1.20

The following table shows the amount of each substance taken from the soil:

Pounds per acre by low land hops (dry).

....	Lbs. per acre (dry)	Nitrogen	K2O	P2O5	CAO
Cones	1357.	26.60	15.26	15.00	18.09
Stems	1027.	5.54	7.29	3.59	15.09
Leaves	723.	8.38	5.54	3.54	32.67
Total	3107.	40.52	27.09	22.13	65. 85

The above table show that much plant food might be wasted by removing the leaves and stalks from the soil. If these waste materials were burned in the field the plants food would with the exception of nitrogen be restored to the soil.

The following table shows the approximate maximum amounts removable per acre annually by other plants. #

Produce	Pounds.		
	Nitrogen	P2O5	K2O
Corn	148.	52.9	85.
Oats	97.	36.8	81.
Wheat	96.	36.8	57.
Timothy Hay	72.	20.7	85.
Alfalfa	400.	82.8	230.

These results show clearly the draft on the soil of the various elements by these plants, yet there is little chance of returning the waste elements to the soil as in the case of the hop, where only a portion of the plant is used.

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