VITIS OPACA, F.v.M., AND A CHEMICAL INVESTIGATION OF ITS ENLARGED ROOTSTOCK (Tuber).


[Read before the Royal Society of N. S. Wales, August 1, 1906.]

Our attention was first drawn to this subject by Mr. B. E. Sampson, Superior Public School, Tamworth, who in June, 1905, sent to the Museum some very fine specimens of 'tubers' from the roots of a Native Grape, and which were exhibited the same month at the Linnean Society of New South Wales. Specimens of the so-called 'tuber' were afterwards received, attached to a whole plant bearing inflorescence and fruits and from which the species was determined as Vitis opaca, F. v. M.

Investigation also proved that of all the species of Vitis recorded by Bentham and Mueller in the “Flora Australiensis,” not one possesses so great a leaf variation as V. opaca, and the leaf variation is so great that it is doubtful whether its description would not almost cover that of V. angustissima, F. v. M., a West Australian species, which however has perhaps a distinct inflorescence from that of V. opaca. Bentham’s description of the leaves of V. opaca, F. v. M.,¹ covers a fair amount of latitude of morphological variation, but the systematic material examined by us shows that this species has a greater leaf variation than that of the material he examined. Under these circumstances we now submit the following amended description of the morphology of the leaf of V. opaca.

¹ B. Fl., Vol. I., p. 450,
"Leaflets 5 to 3 rarely 4, up to 5 inches long, linear, cuneate, elliptical, oblong, obovate, narrow lanceolate to full lanceolate, occasionally irregularly toothed or crenate, narrowed at the base into either a long or very short petiolule, or even sessile; membranous, dull or not shining, finely veined, the underside of the leaves paler than the upper."

A specimen obtained by Mr. Carne, F.G.S., Assistant Government Geologist, from Mount Dangar, Goulburn River, N. S. Wales, has one solitary fair sized leaf which is deltoid in shape, the base being quite straight and the lateral sides below the middle lobed or irregularly toothed.

Baron von Mueller in his Fragmenta, Vol. v., p. 210, mentions that V. opaca produces from 8—10 tubers weighing from 20—25 lbs., and Dr. Woolls is also mentioned (loc. cit.) as recording tubers in connection with V. clematidea, F. v. M.

It would appear from data published concerning the edible character of these "tubers" that it was not unknown to the autochthonous tribes of Queensland, for Dr. Roth records that the tubers of V. trifolius are roasted and used for food, and of V. clematidea that the roots are eaten after being beaten on stones and then roasted. Thozet states that the "yams" as he calls them, of V. opaca, the subject of this paper, are eaten without any preparation.

Chemistry—The tuber taken for analysis weighed 2 lbs. and was in quite a fresh state. It had a diameter of 95 mm. and a length of 190 mm. Externally it had much the appearance of a large potato, and when cut had an odour which also resembled that of the potato. It was covered externally with a thin brown, papery coating. In transverse section it was at first light in colour, but soon became of a pinkish tint when exposed to the air. The juice on
the cut face was not opaque, was quite mucilaginous in appearance, and could be readily drawn out into threads. The 'tuber' as can be seen from the photograph was formed of concentric rings from the centre to the outside, some of these rings were darker in colour than others, and altogether the appearance resembled that shown by the annual rings in timber. There were twelve rings in the specimen taken, so that if the rings are annual the tuber would be 12 years old. Radiating from the centre to the exterior were medullary rays, built up with vascular bundles, spiral vessels being very pronounced. A transverse section was composed almost entirely of ordinary cells, together with the spiral vessels of the vascular bundles forming the radiating portions. A very marked feature of a microscopical section was the presence of an abundance of raphides of calcium oxalate, and the 'tubers' of this species form excellent material for the demonstration of raphides in plant substance. Portions were taken from several tubers and they all presented the same appearance. The raphides were in bundles of needles in the cells, and also as isolated needle crystals, radiating in all directions, or parallel. When a portion of the "tuber" was stained with an aqueous solution of rosaniline and afterwards cleared with glycerol, the ligneous portion of the 'tuber' was seen to be restricted almost entirely to the spiral vessels. A portion stained with iodine coloured alone the starch, and had no action whatever on the cell tissue. The starch granules had much the appearance of those of potato starch, but were generally smaller. There appeared to be no regular deposition of the starch in particular cells, and the granules were sparsely distributed through the mass. The amount of starch present could hardly equal one tenth of one per cent., judging from the microscopic determination and the result of the extraction. Inulin could not be detected; it was specially sought for in the aqueous extract at 50—60° C.
When the mucilage was removed from the pulverised 'tuber,' by treating with water at 50–60°C, the remainder showed the raphides in an excellent manner; the mass appeared to be laced together by them, both in bundles and in single crystals. When thin slices were put into boiling water the substance did not dissolve or break up to any great extent, although it swelled considerably. A portion boiled continuously for four hours, became pinkish-brown in colour, but was then as hard and as uninviting as a food material as when first cut. The liquid was quite acid to test paper, and contained a reducing sugar. Thin pieces of the tuber were entirely soluble in concentrated sulphuric acid on gently warming, and without much darkening. On the addition of water and boiling some time, a considerable amount of reducing sugars had been formed.

100 grams of the tuber were taken and which was in as fresh a state as possible; the outer portions were removed and the remainder cut into small pieces and ground into a pulp in a mortar. Water was added, and the whole stood over night, it was then heated at 50–60°C for two hours. The liquid was quite mucilaginous and dropped from the rod in strings. It was squeezed through cloth, as it was impossible to filter it; a considerable amount had apparently gone into semi-solution. The residue was repeatedly heated at 50–60°C in a fresh supply of water, squeezing through the cloth between each addition until 600 cc. had been obtained, and the extraction was thought to be complete. 60 cc. of this solution, when heated until constant at 100–105°C contained 0.2870 gram total solids, equal to 2.870%. The amount of inorganic residue obtained from this on ignition was 0.820 gram equal to 0.820%. This inorganic residue consisted of potassium and magnesium carbonates, a small amount of phosphates and
a little chlorine. Only a very small amount of calcium was detected and this was evidently due to the accidental presence of a few of the raphides which had passed through the cloth. It is thus apparent that the mucilaginous portion of this tuber consisted largely of the organic salts of potassium and magnesium.

On the addition of an equal volume of 90% alcohol to the mucilaginous solution and shaking, a glairy mass separated in strings, which quickly floated to the top of the liquid. The filtrate was quite clear and bright, and on addition of two volumes of alcohol to this, and standing over night only a very small amount had separated; this had the character of a vegetable substance allied to arabin, but was too small in amount to determine with certainty.

**Moisture**—10 grams of the 'tuber' cut through the centre, were heated at 100-105°C. until constant; the solids weighed 0.4824 gram, so that the water present was 95.176%. A duplicate determination gave 0.4825 gram solids. The dry substance was of a light brown colour and had an odour strongly resembling that of chicory, for which substance it would form a good substitute. It was difficult to prevent any portion becoming brownish when exposed to the air, or to heat, and the aqueous extract soon became slightly coloured, although it was colourless at first. The dried residue when ignited and fully carbonated gave an inorganic residue equal to 1.276% on the tuber.

**Ash**—As the ash of the above contained alumina (a very unusual thing with plant substances belonging to the Phanerogams), a portion of the 'tuber' was taken from the centre so that no possible contamination could take place. The total ash from this was 24.11% on the dried substance a little less than that of the whole tuber and alumina was present. This material was taken for a quantitative deter-
mination. As none of the exterior portion of the 'tuber' was present, and as the ignition was carried out in platinum, the alumina could not have been of accidental origin. The fully carbonated ash was treated with water and, when thoroughly extracted, 100 cc. of alcohol was added and the whole allowed to stand some time. The filtrate was evaporated down and made up to 100 cc., it did not contain either lime, magnesia, sulphuric or phosphoric acids, but chlorine was present. The insoluble portion contained alumina, lime, magnesia, sulphuric acid, phosphoric acid, and carbon dioxide.

The amount of alumina (Al₂O₃) found was 4.955% on the total ash, only the merest trace of iron was present. Almost the theoretical amount of the platinum salt of potassium was obtained and the K₂O calculated from the total chlorides also agreed, thus indicating that sodium was absent. The percentage amount of CaO in the ash was 20.9; of P₂O₅ 2.87; of K₂O 15.74; and of MgO 5.52.

The nitrogen was determined by Kehl Dahl's method giving 2.847% of nitrogen in the perfectly dried substance, or 0.138% on the 'tuber.' The amount of fats and allied substances soluble in ether was 0.788% on the perfectly dry material, or 0.038% of the tuber; a very small amount of a resin was present insoluble in petroleum ether, but this was more readily extracted by alcohol.

Sugar—Only a small amount of substances was extracted by alcohol, and this after removal of the small amount of resin, was found to be largely a crystallised sugar. Special efforts were taken to identify it, and it was determined to be dextrose on the following evidence. A large amount of the pulverised 'tuber' was treated with 90% alcohol for three days. The filtrate, which was colourless, was evaporated to dryness and allowed to stand some time. It was then treated with ether until the resin was dissolved.
The remainder was dissolved in water clarified, and crystallised. Its solution was dextrorotatory, it crystallised well, reduced Fehling's solution readily, had an odour of sugar strongly marked and the osazone melted at 201—5° C. Dextrose is the common sugar of the fruit of the vine, and it is thus also shown to occur in the root of this Vitis. A quantitative determination of a portion of the aqueous solution of the tuber gave 0.402% of reducing sugars.

**Mucilage**—The mucilage was determined in the aqueous extract of the original "tuber" at 50—60° C. as described above. The extract from 100 grams was precipitated with an equal volume of alcohol, the separated glairy mass removed, washed in alcohol, and dried at 100—105° C. 0.6816 gram was obtained equal to 14.13% of the total dried 'tuber,' of this 0.1416 gram represented the fully carbonated ash, or 2.93% of the dried 'tuber.' This ash contained alumina, potassium and magnesium, and a trace of phosphoric acid. Only a small amount of lime was detected and this was due to the few raphides which had passed through the cloth. The mucilage appeared to alter but slightly on long boiling with pure water, and even on boiling with dilute soda, as it separated in an identical manner with an equal volume of alcohol as before treatment; when boiled with very dilute hydrochloric or sulphuric acids it was entirely altered, and on continued boiling reducing sugars were largely formed. When the boiling was only continued sufficiently long that no precipitate took place with two volumes of alcohol, a turbidity was shown; on adding two more volumes of alcohol and on standing, a precipitate was obtained allied to arabin. It is thus seen that the mucilage resembled the ordinary vegetable mucilages soluble in water.
The amount of substance in the dried residue soluble in dilute soda after the water extraction was very small, of no particular interest and was too small to specially determine. Nearly the whole of the substances soluble in dilute hydrochloric acid (0.570%) consisted of calcium oxalate, and the ash (0.339%) was almost entirely calcium carbonate. The amount of cellulose, lignin and allied substances insoluble in the above menstrua was 1.343 gram equal to 27.84% of total dried substance. The small amount of ash from this consisted almost entirely of alumina, indicating that the alumina in the 'tuber' is partly associated with this group of substances.

The above results show that the 'tuber' or enlarged root-stock of this Vitis contained:

<table>
<thead>
<tr>
<th>Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>95.176</td>
</tr>
<tr>
<td>Fats etc., soluble in ether</td>
<td>0.038</td>
</tr>
<tr>
<td>Reducing sugars</td>
<td>0.402</td>
</tr>
<tr>
<td>Other substances soluble in water</td>
<td>2.468</td>
</tr>
<tr>
<td>Substances soluble in HCl</td>
<td>0.570</td>
</tr>
<tr>
<td>Cellulose, lignin, etc.</td>
<td>1.343</td>
</tr>
<tr>
<td>Soluble in NaOH by difference</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Nitrogen 0.138 per cent.
Carbonated ash 1.276 °°° °°°

There seems to be a somewhat close affinity between the carbohydrates of this 'tuber' and those belonging to the group which includes the true gums. The formation of salts indicates the acid nature of these organic substances, and the alteration products are more in the direction of the sugars than the starches. No active principle was detected at any time during the investigation, and tannins seem also to be absent, as the dried 'tuber,' when boiled in water, gave no reaction for tannin with ferric chloride or
with the usual reagents. From the results of this investigation it appears most probable that the 'tubers' of this species of *Vitis* are simply enlarged root stocks, and as found have comparatively little food value. Cultivation might perhaps improve them somewhat in this respect, but this result is not promising.

We are indebted to Messrs. G. Smith and J. W. Tremain for photographs illustrating the paper.

**Explanation of Plates.**

Fig. 1—"Tuber" with root attachment.
Fig. 2—Section (transverse) through fresh specimen.
Fig. 3—Transverse section through withered specimens. This shows more distinctly than Fig. 2 the medullary rays.

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**The Australian Melaleucas and Their Essential Oils.**


Part I.

[Read before the Royal Society of N.S. Wales, August 1, 1906.]

The *Melaleucas* commonly known as "Tea Trees," and which are distributed throughout the whole continent of Australia, (being found in the dry interior as well as on the mountain ranges and coast districts), may almost be regarded as endemic. *M. Leucadendron*, which is recorded also for the Indian Archipelago, may have escaped from this austral mainland. It was upon material of this latter species that Linnaeus founded the genus in 1767, and since then over 100 species have been described as Australian,

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DOI: https://doi.org/10.5962/p.359468
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