

SCIENTIFIC SECTION

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A STUDY OF SEVERAL SPECIES OF THE GENUS MONARDA.*¹

BY B. V. CHRISTENSEN² AND R. S. JUSTICE.³

SECTION NO. 3—SUMMARY OF ASH ANALYSES.

In recent years investigation of the ash constituents of the *Monardas* has brought into literature chemical analyses on several species. In the present study three species, *Monarda pectinata*, *Monarda menthaefolia* and *Monarda punctata* var. *leucantha* were examined. In the following tabulations the analyses presented by A. A. Harwood on *Monarda punctata* (1) and *Monarda fistulosa* (2) are also used. The results are calculated to the basis of anhydrous plant material in order to obviate any discrepancies due to variations in the moisture contents of the samples. The soil samples presented are those of typical soils frequented by the *Monardas* in the states of Wyoming (3), Wisconsin (4) and Florida where the various plant samples were collected.

After a careful perusal and checking of results no outstanding anomalies can be definitely pointed out except in two instances.

In the case of the sulfate determinations in Table I below, it is interesting to note that there is a marked variation in the content of the flower heads and leaves of *Monarda fistulosa* as compared with the other species. This variation is apparently not due to the soil or circumstances other than the fact that the plant itself must enter into the special selectivity for the ion. With regards to this marked variation, the writer calls attention to the fact that *Monarda fistulosa* is the only *Monarda* studied to date in which the presence of thymol has not been definitely established.

TABLE I.—SULFATE IN THE ASH, PERCENTAGE RESULTS.

Plant.	Flower Heads or Bracts.	Leaves.	Stems.	Roots.	Soil.
<i>Monarda menthaefolia</i>	0.31	0.27	0.08	0.12	0.07
<i>Monarda fistulosa</i>	0.54	0.71	0.17	0.15	0.074
<i>Monarda punctata</i>	0.36	0.28	0.32	0.15	0.074
<i>Monarda punctata</i> var. <i>leucantha</i>	0.40	0.25	0.27	0.11	...
<i>Monarda pectinata</i>	0.26	0.24	0.09	0.10	0.07

Note that the leaves of the thymol producing plants have a sulfate content of from 0.24 to 0.28 per cent. *Monarda fistulosa* leaves contain 0.71 per cent or approximately double the amount.

The next important and obvious variation seems to be in the calcium contents of the leaves and flower heads. See Table II. The variations are apparently not

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due to the variations of calcium in the soil but rather to the plant itself or its environment. The writer again calls particular attention to the fact that *Monarda fistulosa*, the carvacrol producing plant, has distinctively the lowest calcium content. *Monarda menthaefolia*, the plant closest related to *Monarda fistulosa* morphologically and the plant producing less thymol and more carvacrol than the other thymol containing plants, comes next to the *fistulosa* in calcium content. All the thymol producing plants contain more than one per cent of calcium in their leaves.

TABLE II.—CALCIUM IN THE ASH, PERCENTAGE RESULTS.

Plant.	Flower Heads or Bracts.	Leaves.	Stems.	Roots.	Soil.
<i>Monarda menthaefolia</i>	0.82	1.11	0.34	0.55	0.82
<i>Monarda fistulosa</i>	0.63	0.77	0.20	0.35	1.14
<i>Monarda punctata</i>	0.78	1.26	0.49	0.26	1.14
<i>Monarda punctata</i> var. <i>leucantha</i>	2.32	2.19	0.62	0.37	Above average
<i>Monarda pectinata</i>	2.00	2.82	1.10	0.50	0.82 to 1.47

The remaining analyses showed no marked variations. This is the case of the magnesium determinations given in Table III.

TABLE III.—MAGNESIUM IN THE ASH, PERCENTAGE RESULTS.

Plant.	Flower Heads or Bracts.	Leaves.	Stems.	Roots.	Soil.
<i>Monarda menthaefolia</i>	0.15	0.31	0.10	0.019	0.75
<i>Monarda fistulosa</i>	0.12	0.13	0.018	0.074	0.073
<i>Monarda punctata</i>	0.10	0.18	0.029	0.02	0.073
<i>Monarda punctata</i> var. <i>leucantha</i>	0.35	0.38	0.095	0.104	0.76
<i>Monarda pectinata</i>	0.23	0.28	0.13	0.13	0.75

The quantity of magnesium present seems to be dependent upon the selectivity of the plant and to its chlorophyll content, certainly not on the soil content of the element.

TABLE IV.—IRON IN THE ASH, PERCENTAGE RESULTS.

Plant.	Flower Heads or Bracts.	Leaves.	Stems.	Roots.	Soil.
<i>Monarda menthaefolia</i>	0.27	0.50	0.13	0.54	2.84
<i>Monarda fistulosa</i>	0.11	0.095	0.050	0.19	2.365
<i>Monarda punctata</i>	0.10	0.15	0.09	0.048	2.365
<i>Monarda punctata</i> var. <i>leucantha</i>	0.018	0.02	Trace	0.010	0.1 to 0.5
<i>Monarda pectinata</i>	0.16	0.28	0.05	0.56	2.84

The iron content of the *Monardas* seems to be influenced by the amount of iron in the soil. Aluminum is not influenced by the quantity in the soil. See Table V below:

TABLE V.—ALUMINUM IN THE ASH, PERCENTAGE RESULTS.

Plant.	Flower Heads or Bracts.	Leaves.	Stems.	Roots.	Soil.
<i>Monarda menthaefolia</i>	1.02	0.66	0.55	0.38	4.50
<i>Monarda fistulosa</i>	0.15	0.18	0.049	0.20	8.197
<i>Monarda punctata</i>	0.25	0.25	0.12	0.07	8.197
<i>Monarda punctata</i> var. <i>leucantha</i>	0.13	0.075	0.027	0.062	...
<i>Monarda pectinata</i>	0.70	0.99	0.21	0.50	4.50

The foregoing correlation of data is the initial step in an attempt to find, if possible, the reason for the peculiar variation in constituents, especially the phenolic constituents, in the

Monardas. It may or may not be due to the presence or absence of elements or radicals in various species. At the same time, this correlation of data may, in time, point out species differences.

In the absence of similar data from other species it is impossible to carry this study further at the present time. However, other determinations were made in the course of the present investigation and the results are presented herewith in Tables VI, VII and VIII.

TABLE VI.—MONARDA PUNCTATA VAR. LEUCANTHA, PERCENTAGE RESULTS.

Determination.	Flower Heads		Stems.	Roots.	Flower Heads Late.
	Early.	Leaves.			
Silicate (SiO ₂)	0.27	0.74	0.44	51.99	0.52
Phosphate (PO ₄)	0.91	0.71	0.48	0.47	1.14
Alkalinity of Ash (CO ₂)	5.68	5.65	1.48	1.31	5.72

TABLE VII.—MONARDA MENTHÆFOLIA, PERCENTAGE RESULTS.

Determination.	Flower Heads.	Leaves.	Stems.	Roots.
Chlorine (Cl)	0.016	0.049	0.044	0.025
Silicate (SiO ₂)	4.45	2.59	0.58	9.38
Phosphate (PO ₄)	0.29	0.31	0.21	Trace
Alkalinity of Ash (CO ₂)	3.27	3.10	2.44	1.93

TABLE VIII.—MONARDA PECTINATA, PERCENTAGE RESULTS.

Determination.	Flower Heads.	Leaves.	Stems.	Roots.
Chlorine (Cl)	0.028	0.026	0.033	0.021
Silicate (SiO ₂)	3.59	12.21	1.17	2.60
Phosphate (PO ₄)	0.11	Trace	0.086	Trace
Alkalinity of Ash (CO ₂)	2.52	1.97	1.82	1.94

Method Used.—The results above are all calculated on the basis of anhydrous plant material.

The various elements and radicals were determined as follows:

- Sulfate (SO₂) as barium sulfate (5).
- Calcium (Ca) as the oxalate and weighed as the sulfate (6) or oxide (7).
- Magnesium (Mg) as the pyrophosphate (8).
- Iron (Fe) by permanganate titration (9).
- Aluminum (Al) by difference (10).
- Silicon dioxide (SiO₂) as such (11).
- Phosphate (PO₄) as the ammonium phosphomolybdate (12) by titration.
- Carbonate (CO₂) as alkalinity of ash by titration (13).
- Chlorine (Cl) by titration (14).

CONCLUSION.

The more common elements and radicals in *Monarda punctata* var. *leucantha*, Nash., *Monarda menthæfolia*, Benth. and *Monarda pectinata*, Nutt., were determined. In some cases these values were compared with similar results for *Monarda punctata*, L., and *Monarda fistulosa*, L. Calcium and Sulfate determinations indicate possibilities of a correlation between ash analyses and the occurrence of characteristic phenolic constituents.

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SECTION NO. 4—THE HISTOLOGY OF MONARDA MENTHÆFOLIA VAR. LEUCANTHA.

Since there have been questions arising as to the authenticity of classifying some groups of *Monardas* as independent species, the histology of the various *Monarda* species is becoming important. As a means of increasing the number of studies on *Monardas* now available the histology of *Monarda punctata* var. *leucantha*, Nash., is presented in the following paper.

Monarda punctata var. *leucantha* shows the characteristics of the Genus *Monarda* of the Labiatae (Lamiaceae) Family as follows:

Corolla two-lipped with lower lip three-lobed and middle lobe longer than lateral ones, two stamens, filaments elongate and anthers with divergent sacs, gynœcium with two carpels, a four-celled ovary, a fruit with four nutlets included in the calyx, leaf blades toothed, flowers in dense racemes, calyx elongated with five lobes. It is also assigned to subgenus *Cheilyctis* due to the fact that the flower clusters are mainly axillary, borne in spike-like interrupted panicles and the stamens do not exceed the curved upper corolla lip. This variety differs from *Monarda punctata*, Linn., externally inasmuch as the corolla is white with purple spots while *Monarda punctata* corolla is yellow with purple spots. See Plates 1, 2, 2A and 3.

The following microscopical studies were carried out upon specimens which had been fixed in formol-acetic acid fixative and double stained with safranin and methylene blue.

THE HISTOLOGY AND DEVELOPMENT OF THE FLOWER.

In the sectioning of the flower heads the various stages in the development of the flower were obtained in detail. The first flower part to become differentiated from embryonic tissue was the calyx. Next the corolla develops and in the course of this development the filament and rudimentary anthers appear. The differentiation of the gynœcium begins at approximately the same time. Up to this time the tissue present is meristematic with no apparent differentiation into cells with other functions.

From this point the embryonic flowers develop the differentiated tissues such as parenchyma, vessels in the veins, epidermis, trichomes and glandular hairs, pollen and meristematic

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