

Coffee Extracts

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IN continuation of our work on the analysis of coffee infusions, we have examined a number of coffee extracts, with and without chicory, for the purpose of ascertaining whether some of the conclusions about the ratios set forth in our first paper¹ could be substantiated for these extracts, as well as to determine, along somewhat different lines, which are discussed in the present paper, the general composition of representative products now on the market. In these variations of the means of attacking the problem, our intention was to arrive at some calculation of composition which is free from certain objections, inherent in old methods, to which we refer later. The standards of composition which we finally suggest are submitted as the outcome of a somewhat intensive study of the whole problem.

The method hitherto generally adopted by most analysts for the determination of the composition of coffee extracts is that originally suggested by Tatlock and Thomson.² These authors calculated the proportion of coffee to chicory from the quantities of caffeine and mineral matter present, the equivalent of coffee being obtained from the caffeine found; after crediting to the coffee its due proportion of mineral matter, that remaining was assumed to come only from chicory (also *cf.* Cox³).

From our experience we find that this method has two objections which may sometimes prove serious. First, whilst we find that the majority of these products contain cane sugar as a sweetening agent, there are a few in which commercial caramel has been used. The composition of this substance may vary considerably, and it may contain as much as 3 per cent. of mineral matter, with the result that in Tatlock and Thomson's method of calculation, the ash of the caramel not being taken separately into account and therefore being credited to the chicory, the latter may be over-estimated by as much as 20 to 30 per cent. It is within our knowledge that this has actually happened inadvertently in the past.

The second objection relates to the difficulty of expressing an opinion whether a sample should be reported genuine or otherwise. The present custom of considering only the proportion of coffee to chicory without any reference to the actual amount of the extractives—that is, the concentration of the extract—is

rather unsatisfactory. On this basis a sample containing 1 per cent. of dry coffee extractives and 2 per cent. of dry chicory extractives may be passed as genuine, whereas objection may be taken to another containing 2 per cent. of dry coffee extractives and 10 per cent. of dry chicory extractives, since the amount of coffee indicated is more than 50 per cent. in the first instance, but less than 50 per cent. in the second.

It may be stated at once that the actual analytical determinations required are those described in our previous paper,¹ *viz.* total solids, ash, caffeine and (in sweetened varieties) sugars.

We suggest two methods of calculation which, although they give the proportions of coffee and chicory used in making the extract, are designed to demonstrate that it is possible to ascertain whether commercial caramel has been used in the manufacture, especially if the variety used incorporates adventitious ash, with or without some non-sugar extractives.

It may be well to emphasise the point that the weights of coffee and chicory used are calculated in the first method from caffeine and extractives, and in the second method from caffeine and ash. In other words, whilst the weight of coffee is derived from caffeine in both calculations, the weight of chicory is derived from the extractives in one method and from the ash in the other. The importance of this is discussed later.

In the *first* method of calculation the ratio of extractives to caffeine for pure coffee is taken as 20 to 1, and the proportion of sugar naturally present in chicory is taken as 25 per cent. of the non-sugar chicory extractives.

Let extractives derived from coffee = caffeine per cent. \times 20 = Y, and total non-sugar extractives per cent. = T.

Then non-sugar extractives due to chicory = $T - Y = C$. Adding $1/4 C$ for sugars naturally present in chicory, we get:

$$\text{Total extractives due to chicory} = 5/4 C = Z.$$

Taking the percentage of extractives in coffee as 24 per cent. and those in chicory as 70 per cent., we get as percentages w/w of coffee and chicory used in preparing the extract:

$$\text{Coffee} = \frac{Y \times 100}{24} = A,$$

$$\text{and chicory} = \frac{Z \times 100}{70} = B.$$

From A and B the percentages of coffee and chicory in the mixture used for making the extract are obtained from:

$$\text{Coffee per cent.} = \frac{A \times 100}{A + B}$$

$$\text{and chicory per cent.} = \frac{B \times 100}{A + B}$$

In the *second* method the principle is the same as in Tatlock and Thomson's method.² The ratios of ash to caffeine and of extractives to ash for pure coffee

are taken as 3.3 to 1 and 6 to 1, respectively, and the ratio of extractives to ash for chicory is taken as 17 to 1. Hence we have:

$$\text{Ash due to coffee} = \text{caffeine per cent.} \times 3.3 = E, \text{ and}$$

$$\text{Ash due to chicory} = \text{total ash} - E = F.$$

From E and F we get:

$$\text{Extractives derived from coffee} = E \times 6 = Y, \text{ and}$$

$$,, ,, ,, \text{ chicory} = F \times 17 = Z.$$

From Y and Z the proportions of coffee and chicory are calculated as in the last part of the first method.

The proportion of coffee to chicory in the mixture used for making the extract could also be calculated directly by the first method given in our previous paper.

TABLE I

Sample No.	1	2	3	4	5	6	7	8
Price per 4 oz.	9d.	9d.	4½d.	6d.	6d.	6d.	6d.	6d.
Total solids, per cent.	64.5	66.1	60.3	57.8	54.9	31.2	55.5	35.2
Reducing sugars (as invert sugar), per cent.	11.2	8.0	15.75	12.4	19.14	13.4	22.0	17.2
Cane sugar, per cent.	38.3	47.2	31.25	32.7	22.4	1.14	14.7	3.4
Non-sugar solids, per cent.	15.0	10.9	13.3	12.65	13.36	16.66	18.8	14.6
Ash, per cent.	1.73	1.22	1.52	1.18	1.18	0.723	1.25	0.95
Caffeine, per cent.	0.259	0.23	0.239	0.132	0.097	0.104	0.107	0.098
<i>Ratios :</i>								
Extractives to caffeine	58/1	47.5/1	55.6/1	95.8/1	137/1	160/1	175/1	150/1
,, ,, ash	8.67/1	8.92/1	8.75/1	10.72/1	11.3/1	23/1	15/1	15.3/1
Ash to caffeine	6.67/1	5.33/1	6.35/1	8.94/1	12/1	6.95/1	11.6/1	9.7/1
Percentage of coffee in the mixture used for preparing the extract, as calculated by:								
First method	55.2	63.0	56.8	38.2	28.5	25	23.1	26.5
Second method	50.4	63.1	52.7	37.4	27.7	48	28.5	35

In Table I are given results on some of the samples of coffee extracts with chicory which were selected to represent different classes of this type of article met with in commerce. It will be seen that the proportion of coffee to chicory in the mixture used for preparing the extract varies rather considerably, as also does the actual amount of extractives derived from coffee. In Nos. 1-5 these proportions calculated by both methods agree, although in the first sample the agreement is, for some reason, not very good; but in samples 6, 7 and 8 there is a

TABLE II

Sample No.	Coffee extract (Y) and chicory extract (Z) as calculated by second method			Non-sugar extractives actually found	Sugar correction for chicory in first method (¼C)	Total
	Y	Z	Total			
1	5.1	14.8	19.9	15.0	2.4	17.4
2	4.6	7.8	12.4	10.9	1.6	12.5
3	4.7	12.4	17.1	13.3	2.1	15.4
4	2.6	12.7	15.3	12.6	2.5	15.1
5	1.9	14.6	16.5	13.3	2.8	16.1
6	2.0	6.5	8.5	16.7	3.6	20.3
7	2.1	15.3	17.4	18.8	4.2	23.0
8	1.9	10.6	12.5	14.6	3.2	17.8

definite discrepancy, and this is further demonstrated in a striking manner by the results recorded in Tables II and III.

In Table II, the total of coffee extractives and chicory extractives calculated by the second method agrees well in samples 1-5 with the total of non-sugar extractives actually found *plus* the allowance of sugar naturally present in chicory; but in samples 6, 7 and 8 there is a definite discrepancy, indicating that the extract contains something other than coffee extractives, chicory extractives and sugar—in all probability caramel, which would introduce not only adventitious ash, but also some non-sugar solids.

TABLE III

Weight of coffee and chicory used to prepare 100 g. of the extract
as calculated by

Sample No.	First method			Second method		
	Coffee g.	Chicory g.	Total g.	Coffee g.	Chicory g.	Total g.
1	21.6	17.5	39.1	21.4	21.1	42.5
2	19.2	11.3	30.5	19.0	11.1	30.1
3	20.0	15.2	35.2	19.7	17.7	37.4
4	11.0	17.8	28.8	10.9	18.2	29.1
5	8.1	20.4	28.5	8.0	20.9	28.9
6	8.7	25.8	34.5	8.5	9.2	17.7
7	8.9	29.7	38.6	8.7	21.8	30.5
8	8.1	22.5	30.6	8.1	15.1	23.2

Reference to Table III will again show that in samples 1-5 there is good agreement in respect of the weights of coffee and chicory used to prepare 100 g. of the extract, as calculated by both methods, although, as previously mentioned, the quantity of chicory is arrived at from the extractives in the one instance and from the ash in the other; and this is as it should be if no ash or non-sugar extractives other than those derived from coffee and chicory are present, since the ratio of extractives to ash in chicory is fairly constant. This ratio may vary widely in caramel, the variation depending on the nature of the caramel and its method of preparation, and in any event it will nearly always be different from that found to hold for chicory. This explains the discrepant results in samples 6, 7 and 8; at the same time these give an indirect proof of the presence of caramel.

The nature of the sugar present also provides a clue to the presence of caramel; in samples 1-5 there was a preponderance of sucrose, and in fact the manufacturers of most of the products stated on the labels that their extracts were prepared from coffee, chicory, and pure cane sugar. In samples 6, 7 and 8 the bulk of the sugar is reducing sugar.

It will readily be seen that if the caramel present introduces extra ash or non-sugar extractives, these may be credited to chicory in both methods of calculation, and with such samples the results cannot even be claimed to be rough approximations. Wholly misleading and faulty conclusions may be drawn if reliance is placed only on the proportions of coffee and chicory indicated without due regard to this disturbing effect of caramel on the ratios.

In Table IV are recorded results obtained on *pure* coffee extracts, a type of product that appears to be only rarely met with in commerce. Two of these were solid, and four were liquid extracts. It will be noted that both the solid extracts

and Nos. 3, 4 and 5 of the liquid extracts were genuine, as the three ratios are within the limits we suggested (*loc. cit.*). It seems reasonable to assume, especially from the results on the solid extracts, that there is no appreciable loss of caffeine in concentrating the extract. The liquid extracts 3, 4 and 5 contained 15.3, 35.1 and 15.5 per cent., respectively, of dry coffee extractives, whereas No. 6 contained only 4.7 per cent. of dry coffee extractives—that is, less than in some sold as coffee extract *with chicory*—and 14.12 per cent. of non-sugar extractives other than those derived from coffee, together with 20.5 per cent. of sugars. The extractives other than coffee extractives may have been derived from chicory, burnt sugar, or both. It seems most unfair that such an article, the major constituent of which is presumably burnt sugar, and which contains only 4.7 per cent. of the extractives of coffee, should be allowed to compete on the market with genuine extracts and should be allowed to be described as pure coffee extract, even if it did not contain chicory, as the makers claim. The label on this sample made anything but modest pretensions to excellence, but no notice was given of the presence of caramel or of anything else than coffee.

TABLE IV

Number	1	2	3	4	5	6
Character	Solid	Solid	Liquid	Liquid	Liquid	Liquid
Total solids, per cent. ..	90.9	99.6	63.2	35.1	15.5	39.3
Reducing sugar as invert sugar, per cent.	—	—	3.1	2.7†	—	3.0
Cane sugar, per cent. ..	*	*	44.8	—	*	—
Non-sugar solids, per cent. . .	—	—	15.3	—	—	18.8
Ash, per cent.	12.52	16.2	2.32	6.01	2.63	1.4
Caffeine, per cent.	7.78	4.2	0.929	1.58	0.66	0.23
<i>Ratios :</i>						
Extractives to caffeine ..	11.7/1	23.7	16.5/1	22.4/1	23.5/1	80.3/1
Extractives to ash ..	7.2/1	6.1	6.6/1	5.9/1	5.9/1	13.4/1
Ash to caffeine	1.6/1	3.8/1	2.5/1	3.8/1	4.0/1	6.0/1
Coffee extract (dry), per cent.	90.9	99.6	15.3	35.1	15.5	4.7
Non-sugar extractives other than those of coffee (dry), per cent.	Nil	Nil	Nil	Nil	Nil	14.1

* If the ratio of extractives to ash is below 7 no added sugar is present.

† This amount is naturally present in coffee.

It appears to us that the difficulty about caramel would not arise and the objection, already referred to, about the actual concentration of the extract might be overcome if standards were adopted on the following lines:

For *pure coffee extracts (liquid)* a minimum percentage of extractives derived from coffee should be present, and we suggest a minimum of 10 per cent. of the dry extractives. This may perhaps be considered a rather low standard, especially as some samples of coffee extract *with chicory* contain as much as 5 per cent. of dry coffee extractives.

Pure coffee extracts (solid) should contain nothing but coffee extractives.

For *coffee extracts with chicory* :

- (i) A minimum percentage of extractives derived from coffee should be present, and
- (ii) the non-sugar extractives other than those of coffee should not exceed a certain multiple of the actual extractives of coffee present.

From the results obtained with samples we have examined and also the analyses published by Cox,³ and, more recently, by Needs,⁴ we suggest a minimum of 4 per cent. of dry extractives of coffee; the non-sugar extractives in (ii) should be not appreciably more than three times the actual extractives of coffee found. This will ensure that the proportion of chicory will never be more than approximately 50 per cent. in the mixture of coffee and chicory used. If the amount of dry coffee extractives in a particular sample is up to the standard and there is any abnormality due to the presence of commercial caramel, some allowance may be made for non-sugar extractives derived from it, as there is no virtue in enforcing a limit for extractives derived from chicory when no objection is raised to those derived from burnt sugar.

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