ELSEVIER

Food Chemistry **54** (1995) 113–117

0308-8146/95/$9.50

Analytical, Nutritional and Clinical Methods Section

Analytical study of the mineral and sugar fractions of peach liqueurs

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(Received 30 June 1993; revised version received and accepted 22 December 1994)

The mineral and sugar fractions of 25 peach liqueurs have been determined in order to characterise these beverages in relation to their base fruit: peach. Fruit components were found in only nine of the liqueurs analysed. Sucrose was the major sugar, together with the polyalcohol sorbitol. Potassium, calcium and magnesium were the major macroelements. In the other liqueurs analysed, β-fructose and α- and β-glucose were the major sugars, sorbitol was not detected, and potassium, calcium and magnesium were in small proportion. These beverages have probably been made by aromatising techniques, without direct addition of the fruit.

INTRODUCTION

Fruit liqueurs are alcoholic beverages whose main natural components are fruits. In their preparation the whole fruit is used, and it has to be ripe in order to give the maximum flavour to the liqueur (George, 1989).

Fruit liqueurs are beverages prepared without fermentation process. They have an alcoholic grade of about 25° and a high sugar content, above 150 g of sugar per litre of product (Coll *et al.*, 1992).

There are no defined techniques for preparing these liqueurs, but they are usually based on alcoholic maceration of fruits or on distillation of macerates aromatised with the base fruit. Some manufactures use other techniques in which the fruit does not directly participate, such as alcoholic dissolutions of different fruit aroma compounds (essences, essential oils, aroma extracts) (Gutiérrez, 1992). These beverages are usually coloured with glucose or sucrose caramel, and they are highly sweetened with grape sugar, honey, glucose and sucrose (as syrup). Acidity regulators (citric acid, sodium citrate, sodium bicarbonate) are also added, and occasionally, stabilisers, antioxidants, and other technological aids (Resolución, 1982).

In this paper, the mineral fraction and the sugar fraction of different peach liqueurs have been analysed in order to characterise these beverages in relation to their base fruit—peach—and to evaluate the participation of the fruit and other components in the preparation of the liqueurs. By means of discriminant analysis and cluster analysis applied to the analytical results obtained, the samples have been grouped and classified.

MATERIALS AND METHODS

Sampling

The most representative peach liqueur brands on the national market (Spain) were selected. Five samples of each brand were studied, each sample corresponding to a different batch of production.

The samples were numbered with two figures, the first one corresponding to the bottle number and the second to the brand and manufactured in

Brand 1	01, 11, 21, 31, 41	—Reinbek (Germany)
Brand 2	02, 12, 22, 32, 42	—Cartagena (Murcia)
Brand 3	03, 13, 23, 33, 43	—Villafranca del Penedés (Barcelona)
Brand 4	04, 14, 24, 34, 44	—Albelda de Iregua (La Rioja)
Brand 5	05, 15, 25, 35, 45	—Barcelona

According to the brand's labels, brand 1 was a beverage prepared from neutral alcohols and peach; brands 2, 3 and 4 were made from neutral alcohols; and brand 5 was prepared from molasses alcohols and peach flavour.

Analytical methods

Sugars and polyalcohol composition was determined by gas chromatography. The samples were prepared previously and the sugars determined as trimethylsilyl derivates, using phenyl-α-D-glucoside as internal standard (Coll *et al.*, 1993). The following sugars and polyalcohols were quantified: β-fructose, sorbose, α- and β-glucose, sorbitol and sucrose.

Mineral composition by atomic absorption spectroscopy was also studied. Mineral macroelements (Na, K, Ca, Mg) and microelements (Cu, Fe, Mn, Zn) were determined. The samples were dry ashed to eliminate the organic matter and the alcohol which affect the determination (González *et al.*, 1988). Then they were transformed into homogeneous solutions with a relatively low viscosity (Torija, 1981; Gutiérrez, 1992).

Statistical study

In order to have a better interpretation of the analytical results, a BMDP 7M discriminant analysis and a BMDP 2M cluster analysis were applied to the data obtained (BMDP, 1985).

RESULTS AND DISCUSSION

Sugar and mineral fractions study

The peach liqueurs analysed have a sugar content derived from the sugar solution used to sweeten them, as well as from the sugar of the base fruit. Table 1 shows that in most of these liqueurs the main sugars are reducing sugars, glucose and fructose, with lower levels of sucrose. Brands 2, 3, 5, and sample no. 14 belonging to brand 4, have contents of β-fructose and α- and β-glucose higher than of sucrose. Sample no. 22 in brand 2 presents the lowest concentration of this disaccharide, 0·94 g/litre. On the contrary, brands 1 and 4 (excepting sample no. 14) have higher concentrations

Table 1. Peach liqueurs: sugars and polyalcohols composition (g/litre)

Sample no.	β-Fructose	Sorbose	α-Glucose	Sorbitol	β-Glucose	Sucrose
01	62·82	2·90	33·43	2·29	35·37	79·43
11	87·88	7·36	39·05	0·78	48·34	54·52
21	54·43	4·70	25·10	1·10	32·66	105·87
31	51·09	1·45	26·81	2·84	22·04	108·11
41	45·90	2·74	27·06	2·76	27·13	118·28
$\bar{x}$	59·82	3·83	30·29	1·95	33·11	93·24
$\sigma n-1$	15·29	2·29	5·83	0·95	9·94	25·97
02	151·65	9·00	103·17	—	119·43	1·50
12	138·37	10·80	97·21	—	118·68	4·28
22	150·59	12·83	127·21	—	136·63	0·94
32	155·90	4·49	104·40	—	123·37	6·84
42	136·74	7·53	104·34	—	126·64	13·30
$\bar{x}$	146·65	8·93	107·27	—	124·95	5·37
$\sigma n-1$	8·56	3·18	11·54	—	7·27	5·02
03	133·00	12·77	37·48	—	27·96	29·46
13	160·17	12·88	80·24	—	97·23	17·36
23	175·05	5·07	100·39	—	90·07	4·78
33	177·03	8·06	104·25	—	92·25	6·72
43	178·25	7·02	100·25	—	90·00	5·45
$\bar{x}$	164·70	9·16	84·52	—	79·50	12·75
$\sigma n-1$	19·16	3·51	27·93	—	28·96	10·65
04	97·00	8·41	30·85	15·79	47·71	170·66
14	130·55	20·65	59·81	—	81·44	23·99
24	84·48	5·18	28·39	16·50	36·16	215·95
34	85·00	3·51	30·35	16·31	36·32	203·26
44	86·83	3·12	35·85	15·17	37·52	198·42
$\bar{x}$	96·77	8·17	37·05	—	47·83	162·46
$\sigma n-1$	19·55	7·28	13·02	—	19·39	79·15
05	146·11	26·54	63·70	—	80·75	20·12
15	108·53	11·69	36·93	—	53·14	123·22
25	149·51	8·00	79·25	—	82·38	9·45
35	156·91	2·94	61·91	—	58·00	50·80
45	140·14	3·89	80·20	—	73·10	24·32
$\bar{x}$	142·24	10·61	64·40	—	69·47	45·58
$\sigma n-1$	20·43	9·56	17·55	—	13·27	45·99

of sucrose. The highest content, 215·95 g/litre is shown by sample no. 24 from brand 4.

The peach is a fruit with a higher proportion of sucrose than glucose and fructose (Souci *et al.*, 1986). On account of these data and according to our results, we believe that the samples belonging to brand 1 and brand 4 (excepting sample no. 14) have probably been prepared from fruit. On the other hand, brands 2, 3 and 5 have been prepared without fruit and their sugars derive exclusively from the inverted sugar solution added during preparation.

Sorbitol is a polyalcohol characteristic of the Rosácea family fruits (apples, pears and peaches), and its presence might confirm the use of fruit in the preparation of beverages. Therefore, its determination is important to characterise and identify fruit liqueurs. Samples from brands 1 and 4 (excepting sample no. 14) show a small concentration of sorbitol, and brands 2, 3 and 5 do not show any.

In the sugar composition of these liqueurs, sorbose appears as a minor sugar. Its presence was detected in all the samples. Although we have not found any data in the scientific literature which may explain its presence, we believe that it is probably formed during the preparation of the liqueur or of the sugar solution.

In relation to the mineral fraction, potassium is the major macroelement in some of the liqueurs analysed. It may be observed that these liqueurs are grouped with respect to potassium and to the other macroelements. Table 2 shows that all the samples from brand 1 and from brand 4 (excepting sample no. 14) have a high concentration of potassium, as well as sodium, calcium and magnesium. The samples belonging to brands 2, 3 and 5 have lower contents of potassium and of the other macroelements. Nevertheless we have to point out that sample no. 35 from brand 5 has concentrations in sodium, potassium and calcium higher than its homologues.

The relationship between potassium and the other macroelements, in particular, calcium and magnesium, is an indicator of the use of fruit in the preparation of the beverage.

Peach is a fruit which has potassium as the major macroelement, having calcium and magnesium in a lower proportion (Souci *et al.*, 1986). Fruits do not contain high levels of sodium, therefore its presence may be due to the addition of certain components, like acidity controllers (sodium citrate, sodium bicarbonate) during the preparation of the liqueurs (Resolución, 1982).

With respect to the microelements (Table 3), iron is the major one, its concentrations being very variable. Sample no. 21 from brand 1 shows the maximum content with 9·91 mg/litre. This is a high value, which makes us suspect contamination with this metal during the liqueur's preparation. Samples no. 25 and no. 45 from brand 5 show the minimum concentration, 0·20 mg/litre.

Among the other microelements, copper presents a very homogeneous concentration in all the samples,

Table 2. Peach liqueurs: macroelements composition (mg/litre)

Sample no.	Na	K	Ca	Mg
01	58.97	310.50	32.00	43.00
11	54.00	324.50	67.50	43.33
21	71.50	328.00	77.85	45.92
31	67.66	342.67	39.00	46.33
41	81.67	356.00	51.80	42.00
$\bar{x}$	66.76	332.33	53.63	44.12
$\sigma n-1$	10.83	17.49	19.13	1.90
02	3.50	2.00	6.50	1.00
12	4.66	4.33	4.33	5.33
22	3.50	1.50	9.00	1.00
32	4.67	5.00	6.67	1.00
42	5.33	3.00	7.50	1.00
$\bar{x}$	4.33	3.17	6.80	1.87
$\sigma n-1$	0.81	1.49	1.70	1.94
03	4.00	6.00	3.50	2.00
13	5.00	7.00	3.00	2.00
23	4.50	7.50	3.00	1.50
33	4.33	6.33	2.33	1.50
43	4.00	5.00	4.67	2.00
$\bar{x}$	4.37	6.37	3.30	1.80
$\sigma n-1$	0.41	0.96	0.87	0.27
04	48.47	298.00	29.55	24.80
14	5.33	4.20	6.73	9.50
24	44.33	254.66	17.66	30.00
34	39.50	282.50	31.05	21.55
44	31.20	305.20	31.70	24.13
$\bar{x}$	33.77	228.91	23.34	22.00
$\sigma n-1$	17.14	127.10	10.91	7.63
05	3.00	2.00	4.00	1.00
15	3.00	2.00	4.00	1.00
25	2.00	3.75	4.50	1.00
35	73.75	17.85	7.10	0.93
45	3.00	1.30	3.80	1.00
$\bar{x}$	16.95	5.38	4.68	0.99
$\sigma n-1$	31.75	7.02	1.38	0.03

and manganese and zinc show very low values. Manganese has been detected at trace levels in brands 2, 3 and 5 in sample no. 14 from brand 4. The presence of these microelements in these beverages may be due to leaching from the apparatus used during the preparation (distillers, alembics). The addition of certain components (alcohol, sugar solutions) may also contribute to the presence of these metals. Harju and Ronkainen (1984) consider that the contribution to these microelements by the alcohol is of only μg/litre and this is not significant, but, on the contrary, the sugar solutions may make a considerable contribution. In relation to the fruit, the peach is a fruit poor in these microelements, and only iron is in a higher proportion (Souci *et al.*, 1986).

The relationship between certain components of the mineral fraction and of the sugar fraction in the fruit may be extended to some of the peach liqueurs studied, and this is an indicator of the use of fruit in the preparation of the beverage.

Table 3. Peach liqueurs: microelements composition (mg/litre)

Sample no.	Cu	Fe	Mn	Zn
01	0·39	5·83	0·51	0·90
11	0·50	5·78	0·42	0·85
21	0·44	9·91	0·63	0·93
31	0·54	2·89	0·44	0·80
41	0·61	3·19	0·58	1·15
$\bar{x}$	0·50	5·52	0·52	0·93
$\sigma n-1$	0·08	2·82	0·09	0·13
02	0·30	0·33	0·02	0·60
12	0·66	0·23	0·01	0·60
22	0·34	0·33	0·02	0·25
32	0·38	0·23	0·01	0·40
42	0·37	0·36	0·01	0·43
$\bar{x}$	0·41	0·30	0·01	0·46
$\sigma n-1$	0·14	0·06	0·00	0·15
03	0·36	0·42	0·01	0·45
13	0·28	0·56	0·02	0·50
23	0·23	0·47	0·01	0·30
33	0·54	0·38	0·01	0·50
43	0·36	0·40	0·02	1·40
$\bar{x}$	0·35	0·45	0·01	0·63
$\sigma n-1$	0·11	0·07	0·00	0·44
04	0·40	0·70	0·14	0·90
14	0·51	0·35	0·02	0·40
24	0·89	1·69	0·12	0·57
34	0·65	1·15	0·15	0·90
44	0·43	0·75	0·17	0·85
$\bar{x}$	0·58	0·93	0·12	0·72
$\sigma n-1$	0·20	0·51	0·06	0·23
05	0·26	0·26	0·02	0·25
15	0·24	0·25	0·01	0·90
25	0·20	0·20	0·02	0·50
35	0·55	0·48	0·01	0·60
45	0·20	0·20	0·01	0·55
$\bar{x}$	0·29	0·28	0·01	0·56
$\sigma n-1$	0·15	0·12	0·00	0·23

The liqueurs from brands 1 and 4 (excepting sample no. 14) show high contents in potassium, calcium and magnesium, and sucrose and sorbitol have been detected too, therefore fruit (and/or fruit juice) has been used, using macerating techniques during their preparation.

On the other hand, brands 2, 3 and 5, and sample no. 14 from brand 4, do not show high contents of potassium, calcium and magnesium, while sucrose and sorbitol were not detected. These samples were probably prepared by aromatisation, by addition of essences or by distillation of fruit macerates.

We have observed this same relationship in a previous study of 25 apple liqueurs. We detected sorbitol in all the samples and the major macroelements were potassium, calcium and magnesium (Gutiérrez, 1992; Coll *et al.*, 1993). These results indicated the use of fruit in the preparation of the liqueurs. Postel and Adam (1984) also established a relationship between these components and the use of apple juice to elaborate German apple liqueurs.

Statistical study

By means of discriminant analysis, the variables which best discriminate the five brands have been selected: β-fructose, sorbitol, β-glucose, potassium and magnesium. The variables most directly related to the base fruit are predominant: sorbitol, potassium and magnesium. With the selected variables, the lineal classification functions are calculated, enabling each case to be included in its corresponding group (Table 4). The classification matrix shows that not all the samples are correctly classified (Table 5). Two samples from brand 3 (no. 03 and no. 13) are classified as belonging to brand 5 and the sample no. 35 from brand 5 as belonging to brand 3. The other samples are correctly classified in their corresponding brands (brands 1, 2 and 4).

Table 4. Classification functions

	Brand 1	Brand 2	Brand 3	Brand 4	Brand 5
β-Fructose	0·13064	0·65270	1·12717	0·78395	0·94802
Sorbitol	−42·87238	1·56494	2·24565	−0·93985	2·12294
β-Glucose	0·24639	0·12724	−0·37995	−0·11764	−0·30979
Potassium	1·71187	−0·01998	−0·05603	0·05050	−0·05066
Magnesium	15·17482	0·99746	0·87720	3·29440	0·58575
Constant	−586·89209	−58·31735	−79·93976	−72·74649	−57·47577

Table 5. Classification matrix

Group	Correct percentage	Number of cases classified in each group				
		Brand 1	Brand 2	Brand 3	Brand 4	Brand 5
Brand 1	100·00	5	0	0	0	0
Brand 2	100·00	0	5	0	0	0
Brand 3	60·00	0	0	3	0	2
Brand 4	100·00	0	0	0	5	0
Brand 5	80·00	0	0	1	0	4
Total	88·00	5	5	4	5	6

Table 6. Canonical variable coefficients

Variable	Coefficients			
β-Fructose	−0·02314	−0·06139	−0·04415	0·06122
Sorbitol	−1·33618	0·37984	−0·34487	0·07816
β-Glucose	0·01306	0·07129	0·05682	0·01037
Potassium	0·05235	−0·01629	0·01837	−0·00225
Magnesium	0·42138	0·08235	−0·15477	0·15823
Constant	−6·17811	2·00166	2·42494	−10·39229

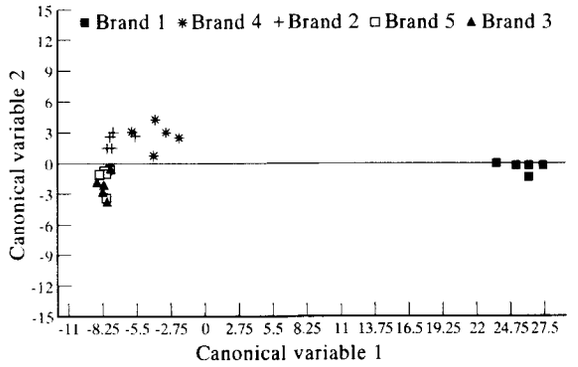

Fig. 1. Situation of peach liqueurs in canonical variable 1 against canonical variable 2.

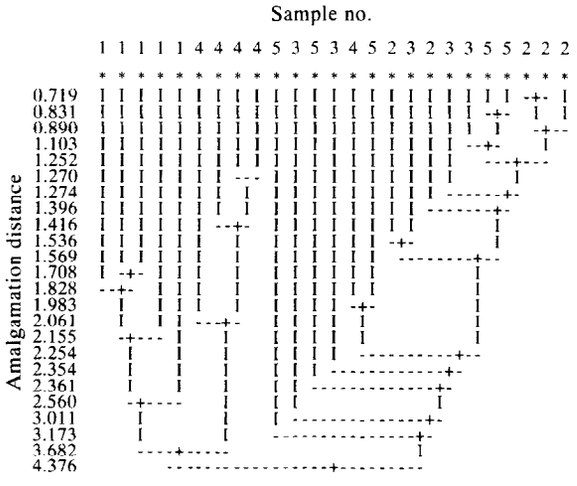

Fig. 2. Cluster analysis dendrogram of peach liqueurs.

The canonical variable coefficients (Table 6) enable us to represent graphically all the cases. Figure 1 is a plot of the first two canonical variaties for the peach liqueurs studied. It is remarkable how the samples belonging to brand 1 are grouped, and the distance between this brand and the others. Brands 3 and 5 are in the neighbourhood and some of their samples overlapped. Sample no. 14, belonging to brand 4, is positioned very near brands 3 and 5.

The cluster analysis forms clusters of cases based on the Euclidean distance and on the single linkage. The dendrogram (Fig. 2) describes the clustering of the samples into the following three groups:

(1) Five samples belonging to brand 1.
(2) Four samples belonging to brand 4.
(3) The remaining samples belonging to brands 2, 3 and 5, and the sample no. 14 from brand 4. This sample, as we have already remarked, has a different behaviour from its homologous samples with respect to its mineral and sugar fractions, being similar to brands 2, 3 and 5.

Both studies, discriminant analysis and cluster analysis, clearly differentiate brand 1 (German) from the others (Spanish), showing differences derived not only from the liqueur's preparation but also from the characteristics of the fruit used.

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