PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A23F 5/04, 5/12, 5/10

A1

(11) International Publication Number: **WO 95/14390**

(43) International Publication Date: 1 June 1995 (01.06.95)

(21) International Application Number: PCT/US93/11476

(22) International Filing Date: 24 November 1993 (24.11.93)

(71) Applicant: THE PROCTER & GAMBLE COMPANY [US/US]; One Procter & Gamble Plaza, Cincinnati, OH 45202 (US).

(72) Inventors: JENSEN, Mary, Ries; 1244 Garden Circle, Cincinnati, OH 45215 (US). KIRKPATRICK, Steven, Jacob; 5688 Krystal Court, Cincinnati, OH 45252 (US). LEPPLA, Jeffrey, Keith; 5480 Windridge Court, Cininnati, OH 45243 (US).

(74) Agents: REED, T., David et al.; The Procter & Gamble Company, 5299 Spring Grove Avenue, Cincinnati, OH 45202 (US).

(81) Designated States: AU, BB, BG, BR, BY, CA, CZ, FI, HU, JP, KP, KR, KZ, LK, LV, MG, MN, MW, NO, NZ, PL, RO, RU, SD, SK, UA, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: HIGH-YIELD ROASTED COFFEE WITH BALANCED FLAVOR

(57) Abstract

Green coffee beans are dried prior to roasting to a moisture content of from 0.5 to 7 %. The drying is conducted at from 70° to 325 °F (21° to 163 °C) for from 1 minute to 24 hours. The dried green beans are fast roasted to a Hunter L-color of from 10-16. The dried roasted beans are blended with non-dried coffee beans roasted to a Hunter L-color of from 17-24 and having a moisture content before roasting of greater than about 7 %. The blend contains from 1-50 % of the dried dark roasted beans and from 50-99 % of the non-dried roasted beans. The blend has a surprisingly high yield.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**GB**	United Kingdom	**MR**	Mauritania
AU	Australia	**GE**	Georgia	**MW**	Malawi
BB	Barbados	**GN**	Guinea	**NE**	Niger
BE	Belgium	**GR**	Greece	**NL**	Netherlands
BF	Burkina Faso	**HU**	Hungary	**NO**	Norway
BG	Bulgaria	**IE**	Ireland	**NZ**	New Zealand
BJ	Benin	**IT**	Italy	**PL**	Poland
BR	Brazil	**JP**	Japan	**PT**	Portugal
BY	Belarus	**KE**	Kenya	**RO**	Romania
CA	Canada	**KG**	Kyrgystan	**RU**	Russian Federation
CF	Central African Republic	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CG	Congo			**SE**	Sweden
CH	Switzerland	**KR**	Republic of Korea	**SI**	Slovenia
CI	Côte d'Ivoire	**KZ**	Kazakhstan	**SK**	Slovakia
CM	Cameroon	**LI**	Liechtenstein	**SN**	Senegal
CN	China	**LK**	Sri Lanka	**TD**	Chad
CS	Czechoslovakia	**LU**	Luxembourg	**TG**	Togo
CZ	Czech Republic	**LV**	Latvia	**TJ**	Tajikistan
DE	Germany	**MC**	Monaco	**TT**	Trinidad and Tobago
DK	Denmark	**MD**	Republic of Moldova	**UA**	Ukraine
ES	Spain	**MG**	Madagascar	**US**	United States of America
FI	Finland	**ML**	Mali	**UZ**	Uzbekistan
FR	France	**MN**	Mongolia	**VN**	Viet Nam
GA	Gabon				

HIGH-YIELD ROASTED COFFEE WITH BALANCED FLAVOR

FIELD OF THE INVENTION

The present invention relates to high yield roasted coffee with balanced flavor and a process for making it.

BACKGROUND OF THE INVENTION

Numerous attempts have been made in the past to make roasted coffee which has both an enhanced brew coffee yield (volume of coffee brew per weight of roasted coffee) and an acceptable brewed flavor.

It is known that the extractability of roasted coffee (the amount of brew solids which can be extracted from a given weight of coffee from which a coffee brew is made) can be increased by grinding the roasted coffee to finer particles sizes. These fine grinds, however, are physically difficult to brew. The fine particles are subject to pooling, channeling and compaction during brewing. Fine grinds also have an undesirable balance of flavor and strength.

It is also known that extractability can be enhanced by flaking roast and ground coffee. Flaking involves roll milling a roast and ground coffee. More coffee can be brewed from flaked coffee due to the increased extractability. However, flaked coffee has lower levels of container aroma. It also lacks a desirable balance of flavor and strength.

It is known that fast roasting of coffee beans can also increase brew coffee yields. Roasting times affect product density and extractability. Fast roasted coffee, i.e., roast times less than about 5.5 minutes, is less dense than longer roasted coffee. Fast roasted coffee also provides an enhanced extractability. Fast roasted coffee, however, can also lack a desirable balance of flavor and strength.

It can be seen that enhancing extractability and brew coffee yield can be achieved but often at the expense of balanced flavor of the coffee brew.

There is therefore a need to provide a roasted coffee that has both an enhanced brew coffee yield (referred to herein as high-yield) and a balanced flavor.

SUMMARY OF THE INVENTION

The invention is a high-yield roasted coffee with balanced flavor and a process for making it. Green coffee beans are dried prior to roasting to a moisture content of from about 0.5 to about 7%. The drying is conducted at temperatures of from about 70° to about 325°F (about 21° to about 163°C) for from about 1 minute to about 24 hours. The dried coffee beans are fast roasted to an extreme Hunter L-color of from about 10 to about 16. The dried dark roasted coffee beans are blended with non-dried roasted coffee beans having a moisture content before roasting of greater than about 7%. The blend comprises from about 1 to about 50% of the dried dark roasted beans and from about 50 to about 99% of the non-dried roasted beans.

The dried dark roasted beans provide strength with minimal burnt-rubbery flavor notes. The non-dried beans provide flavor and acidity. The resulting blend has a desirable balance of strength, flavor and acidity in a high-yield roasted coffee.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 illustrate gas chromatograms for strength compounds including ethyl quaiacol. Figures 3 and 4 illustrate gas chromatograms for burnt-rubbery compounds. Figure 5 illustrates a gas chromatogram for good flavor compounds. Analytical methods used to generate the chromatograms are described hereinafter.

DETAILED DESCRIPTION OF THE INVENTION

The process of the invention involves three key steps. A first step involves drying green coffee beans. A second step involves fast

roasting the dried beans to an extremely dark roast. A third step involves blending the dried dark roasted beans with roasted non-dried coffee beans.

The product of the invention, made by the process herein, contains a unique and critical balance of strength and good flavor compounds and acidity.

As used herein, all percentages and ratios are based on weight unless stated otherwise.

A) Drying Green Coffee Prior to Roasting

In the drying step, green coffee beans having an initial moisture content greater than about 10%, preferably from about 10 to about 14%, are dried prior to roasting. The dried beans have a moisture content of less than about 7%, preferably from about 3 to about 7%.

The drying should be conducted under gentle conditions. Large heat inputs and temperature differentials can result in tipping, burning or premature roast-related reactions of the coffee beans. The green beans are dried in an apparatus containing from 0 to 70% moisture. Drying temperatures are from about 70° to about 325°F (about 21° to about 163°C), preferably from about 160° to about 250°F (about 71° to about 121°C). Drying times are from about 1 minute to about 24 hours, preferably from about 2 to about 6 hours.

The drying step results in partially dehydrated coffee beans without causing significant roasting-related reactions to take place. Roasting reactions are described in Sivetz et al., "Coffee Technology", AVI Publishing Company, Westport, Conn., pp. 250-262 (1979), incorporated herein by reference.

Drying methods and apparatuses for use in the drying step are disclosed in U.S. Patent Application 07/737,576, filed July 26, 1991, which is incorporated herein by reference.

After the coffee beans are dried, they are subjected to a roasting step described hereinafter. The coffee beans should have minimal contact, preferably no contact, with moisture between the drying and roasting steps.

B) Dark Roasting Dried Coffee Beans

In the roasting step, the dried coffee beans are dark roasted to a Hunter L-color of from about 10 to about 16, preferably from about 12 to about 16, most preferably from about 14 to about 16. The dried dark roasted beans have tamped densities of from about 0.28 to about 0.42 grams/cc.

Conventional fast roasting methods are used. Roasting temperatures are from about 350° to about 1200°F (about 177° to about 649°C), preferably from about 400° to about 800°F (about 204° to about 427°C). Roast times are from about 10 seconds to about 5.5 minutes, preferably from about 1 to about 3 minutes. Fast roasting is described in U.S. Patent Application 07/737,576 filed July 26, 1991. Fast roasting is also described in Sivetz, Coffee Technology, AVI Publishing Company, Westport, Conn., pp. 226-246 (1979), which is incorporated herein by reference.

At the desired Hunter L-color, the dark roasted beans are removed from the roaster heat. The beans are promptly cooled by typically ambient air and/or a water spray. Cooling the beans stops roast-related pyrolysis reactions.

It has been found that roasting the dried beans to the extreme Hunter L-colors develops strength compounds with minimal development of burnt-rubbery flavor compounds. The specific compounds are defined hereinafter. Dark roasting non-dried coffee beans, especially low quality beans such as Robustas, to these extremes would result in excessive burnt-rubbery flavor notes.

C) Blending Dried and Non-Dried Coffee Beans

The dried dark roasted coffee beans are blended with non-dried roasted coffee beans. The dried beans provide strength with minimal burnt-rubbery flavor notes. The non-dried beans provide flavor and acidity. The blend comprises from about 1 to about 50%, preferably from about 1 to about 20%, most preferably from about 5 to about 15% of the dried beans and from about 50 to about 99%, preferably from about 80 to about 99%, most preferably from about 85 to about 95% of the non-dried beans.

The non-dried beans are derived from green coffee beans having a moisture content prior to roasting of above about 7%, preferably

from about 10 to about 14%. These green beans are not subjected to the drying step prior to roasting. The non-dried green coffee beans are roasted, preferably fast roasted, to a Hunter L-color of from about 17 to about 24. The non-dried roasted beans have tamped densities of from about 0.28 to about 0.42 grams/cc.

Both the dried and non-dried beans can be derived from low, intermediate or high quality coffee beans, or mixtures thereof. Preferably the dried beans are derived from intermediate or low quality beans or mixtures thereof, more preferably from low quality coffee beans, most preferably from Robustas. The non-dried beans are preferably derived from intermediate or high quality beans or mixtures thereof.

As used herein, non-limiting examples of high quality coffee beans include "Milds" (high grade Arabicas) such as Colombians, Mexicans, and washed Milds such as strictly hard bean Costa Rica, Kenyas A and B, and strictly hard bean Guatemalans. As used herein, non-limiting examples of intermediate quality coffee beans include Brazilians and African naturals. As used herein, non-limiting examples of low quality coffee beans include Robustas, low grade Naturals, low grade Brazils, and low grade unwashed Arabicas.

It has been found that flavor strength in the coffee blends can be derived from relatively few coffee beans. In the blended coffee, the high-strength beans (dried dark roasted beans) preferably represent only from about 5 to about 15% of the blended beans. This small fraction of beans has a high f(1) value (ratio of strength compounds to burnt-rubbery compounds) and a low f(2) value (amount of good flavor compounds). These values are listed in Table 1 and described hereinafter.

Very small amounts of these dried dark roasted beans can now be added to weak but flavorful coffees (i.e., high quality coffee such as Colombian). The result is a flavorful, full-strength coffee unadulterated by excessive burnt-rubbery flavor notes.

D) Admixture of Flakes and Roast and Ground Coffee

Optionally, the blend of roasted dried and non-dried coffee beans are ground, normalized and milled to an average flake thickness of

from about 102 to about 1016um (about 0.004 to about 0.04 inches), preferably from about 102 to about 508um (about 0.004 to about 0.002 inches), most preferably from about 102 to about 254um (about 0.004 to about 0.01 inches). Flaked coffees are described in: U.S. Patent 5,064,676; U.S. Patent 4,331,696; U.S. Patent 4,267,200; U.S. Patent 4,110,485; U.S. Patent 3,660,106; U.S. Patent 3,652,293; and U.S. Patent 3,615,667, all of which are incorporated herein by reference.

Additionally, the flaked blend can be admixed with roast and ground coffee. The admixture comprises from about 10 to about 50%, preferably from about 25 to about 50% of the flaked blend and from about 50 to about 90%, preferably from about 50 to about 75% of the roast and ground coffee. The roast and ground coffee comprises the non-dried roasted beans, the dried roasted beans, or mixtures thereof, preferably the non-dried roasted beans.

It was found that thin flaking the dried dark roasted coffee beans, or blends containing the dried beans, results in a surprisingly dark cup color. Flaking increases brew solids by about 20% but increases cup color by about 40%. Cup color is important to consumer perceptions. Although cup color per se does not contribute to coffee flavor or strength, brewed coffee with darker colors are perceived as having richer, stronger flavors.

E) Characteristics of the Coffee Product

The coffee product of the invention has a unique chemistry profile. The unique chemistry provides a balanced flavor and a surprisingly high yield.

1) Chemistry Profile

The chemistry profile of the coffee product is defined by f(1), f(2), and f(3) values wherein f(1) is greater than about 900, f(2) is greater than about 1200 and f(3) is greater than about 125. These values are determined as follows.

f(1) = 10,000 x [strength compounds] / [burnt-rubbery compounds]

f(2) = 100 x [ethyl guaiacol]

f(3) = 100 x [good flavor compounds] / [flavor strength compounds]

Strength compounds = [pyrazine + pyridine + pyrrole + guaiacol + ethyl guaiacol]

Burnt-rubbery compounds = [3-thiazole + 4-methylthiazole + peak 13 + peak 14 + peak 15 + tetrahydothiophene + peak 17 + 2-thiophenecarboxaldehyde + peak 19 + 3-acetylthiophene + 2-acetylthiophene + peak 22]

Good flavor compounds = [ethanal + propanal + 2-pentanone + 3-pentanone + 2,3-pentanedione].

Individual compounds are measured in terms of total GC counts. Methods for measuring GC counts for each of the three compound groups (strength, good flavor, burnt-rubbery) are described hereinafter. The unknown "peak" compounds are
defined hereinafter.

The chemistry of the coffee product is unique when compared to conventional and/or dark roasted coffee. As shown in Table 1, only the coffee product of the invention has the critical combination of f(1), f(2) and f(3) values.

TABLE 1

Function	Vacuum Folgers	Maxwell House Master Blend	Chock Full of Nuts Ultra-Roast	French Roast	Splendid Italian Expresso
f(1)	710	1000	870	940	1320
f(2)	770	835	1060	750	2140
f(3)	310	150	210	220	50

TABLE 1 (continued)

Function	Dried Roasted Coffee	Non-Dried Roasted Coffee	Blend of the Dried (10%) and Non-Dried (90%) Coffee
f(1)	4300	700	1060
f(2)	7600	1000	1660
f(3)	95	200	190

The Table 1 coffees are defined as follows. Vacuum Folgers is a 13 ounce, automatic drip grind (ADC) coffee manufactured by The Procter & Gamble Company, code date 2133N. Maxwell House Master Blend is an 11.5 ounce, ADC coffee manufactured by General Foods, code date 2054. Folgers French Roast is a 12 ounce, dark roast, ADC coffee made by The Procter & Gamble Company, code date 2106. Chock Full of Nuts Ultra Roast is an FAC (for all coffeemakers) coffee manufactured by Chock Full of Nuts Corp., code date 1N20. Splendid Italian Expresso is a 17.6 ounce, fine grind coffee manufactured by The Procter & Gamble Company, code date Mar90. The dried and non-dried coffees are the components of the 10:90 blend. The blend is a high-yield, balanced flavor coffee of the invention.

2) Balanced Flavor Benefit

The chemistry profile of the coffee product provides a balanced flavor to coffee brews. Other coffee products have from zero to two of the f(1), f(2) or f(3) values in the ranges recited herein. However, it is the combination of all three values at the recited levels that is critical.

f(1) relates flavor strength to burnt-rubbery flavor. It is desirable to achieve a high f(1) value especially in high-yield coffee (i.e., low density, fast roasted coffee). High-yield coffees often have increased flavor strength and increased burnt-rubbery flavor. The coffee product of this invention has increased flavor strength but

only minimal increased burnt-rubbery flavors. The dried dark roasted beans provide this benefit to the coffee product.

f(2) relates to ethyl guaiacol levels. Ethyl guaiacol provides flavor strength. The high f(2) value indicates a selectively developed strength component from the dried roasted coffee beans.

f(3) relates good flavor to flavor strength. It is desirable to increase f(3) to develop a balance of good flavor with increased flavor strength. The good flavor arises from the non-dried roasted coffee beans. The flavor strength arises from the dried dark roasted coffee beans.

3) High Yield Benefit

It was found that the coffee product of the invention has a surprisingly high yield. As used herein, "yield" means the weight in grams of a roasted coffee needed to brew one cup of coffee. Yields for various coffees are listed in Table 2.

TABLE 2

Coffee type (weight per 1000cc volume of roasted coffee)	Weight of roasted coffee needed to make one cup of brewed coffee (grams/cup)
Conventional roast and ground coffees:	
16 ounce coffee	5.16
13-ounce coffee*	4.20
11.5-ounce coffee*	3.71
10.5-ounce coffee*	3.39
High-yield coffee of the invention:	
(13-ounce)*	2.58

*fast roasted, low density coffee

The roasted coffee product of the invention yields from about 30 to about 100% more brewed coffee. It also yields from about 30 to about 63% more brewed coffee than other low density, fast roasted coffee. The phrase "cup of brewed coffee" in Table 2 means coffee brews that are organoleptically similar to or better than that of conventionally brewed roast and ground coffee.

This high-yield coffee can be combined with soluble coffees or admixed with non-coffee materials. It can be caffeinated or decaffinated. It can also be added to filter packs or used to manufacture soluble coffee.

4) Acidity

Brewed coffee from the coffee product has a brewed acidity index of above about 2200. The brewed acidity index described hereinafter is the expression of coffee acidity used herein. Brewed coffee with a brewed acidity index of less than about 2200 lacks the acidity which is necessary for acceptable coffee flavor.

ANALYTICAL METHODS

A) Analysis of Strength Compounds including Ethyl Guaiacol

1) Analytical Method

The simultaneous steam distillation and extraction (SDE) method disclosed by Schultz et al., J. Agric. Food Chem. 25, 446-449 (1977), followed by capillary gas chromatography (CGC) of an SDE extract, is used to analyze the flavor strength compounds including ethyl quaiacol. The combined SDE-CGC method is disclosed in U.S. Patent 4,857,351 to Neilson et al., issued August 15, 1989, which is incorporated herein by reference.

An SDE extract (0.3ml) is obtained from a roast and ground coffee by the SDE method described in U.S. Patent 4,857,351. The extract is analyzed with a Hewlett-Packard 5880A Capillary Gas Chromatograph (HP-CGC). The HP-CGC has a fused silica column (DB5 column, 60 meter

length, 0.32mm internal column diameter, from J&W Scientific, Inc. of Cardova, California) and a flame ionization detector (FID) to detect the carbon and hydrogen of the volatile compounds in the SDE extract. The column contains a film of crosslinked polyethylene glycols 1.0um thick. A Hewlett-Packard Level Four data terminal is used to process the data for retention times, peak areas and area percents.

2) Application of the Analytical Method

Roast and ground coffee (5.0 grams) is placed in a 500cc round bottom flask. Distilled water (200 grams) is added to the flask. Internal standard (3ml) and boiling stones are added to the flask. The preferred internal standard is isoamyl acetate (5mcl) dissolved in methylene chloride to make 100ml. Contents of the flask are then processed into an SDE extract. The extract (3mcl) is injected on to the column. The GC oven is maintained at 25°C (77°F) for 2.6 minutes. The oven temperature is raised 20°C/min. to 45°C (113°F) and then held for 7 minutes, raised again at 3.0°C/min. to 65°C (149°F) and then held for 6 minutes, raised again at 2.0°C/min. to 125°C (257°F) and held for 1 minute, raised again at 3.0°C/min. to 220°C (428°F) and held for 6 minutes, and finally raised to 230°C (446°F) and held for 30 minutes.

Conditions for the HP-CGC:

Septum purge flow	1 cc/min.
Inlet pressure	26 psig
Vent flow	30 cc/min.
Make-up carrier flow	30 cc/min.
Flame Ionization Detector:	
Hydrogen flow rate	30 cc/min.
Air flow rate	400 cc./min.
Column flow	3 cc./min.
Split ratio	10/1

Figures 1 and 2 are gas chromatograms from the SDE-CGC analytical method using SDE extract obtained from the roasted coffee of the present invention. Peaks are labeled 6 to 10 which correspond to

pyrazines (6), pyridines (7), pyrroles (8), guaiacols (9), and ethyl guaiacols (10).

The chromatogram is analyzed by determining the area of each recorded peak. The peaks are proportional to the GC counts (digitized electrical impulses proportional to GC peak areas).

Total GC counts as used herein are corrected GC counts. GC counts of each peak of a sample extract are normalized (corrected) to make all of the sample extracts on the same basis for comparison by ratioing the GC counts of each peak to the GC counts of the internal standard.

Corrected GC counts for a given compound are calculated using the following equation:

$$\text{Corrected GC Counts} = \frac{\text{Area of a GC Peak}}{\text{Area of the Internal Standard Peak}} \times \text{Response Factor} \times \text{Dilution Factor}$$

Response factors for specific compounds include pyrazine (1.200), pyridine (0.660), pyrrole (0.950), guaiacol (0.740) and ethyl guaiacol (1.000).

B) Analysis of Burnt-rubbery Compounds

This method is used to analyze burnt-rubbery compounds. It is similar to that used in analyzing the flavor strength compounds. Differences in the two methods are described below.

The SDE extract is analyzed by a HP-CGC and a Supelcowax-10 fused silica column (Supelo, Inc. of Bellefontaine, Pennsylvania). The column is used with a flame photometric detector (FPD) to detect volatile sulfur compounds (i.e., burnt-rubbery compounds) in the SDE extract.

In making the SDE extract, the preferred internal standard is 2,5-dimethyl thiophene dissolved in methylene chloride (10 mcl diluted to 25ml in a first dilution, then 6ml diluted to 200ml in a second dilution).

The SDE extract is injected on to the column. The GC oven is maintained at 50°C for 3.00 minutes. The oven temperature is raised

2.0°C/min. to 100°C and then held for 15 minutes, raised again at 1.00°C/min. to 130°C and then held for 1 minute, and then raised to 201°C and held for 5 minutes.

Figures 3 and 4 are gas chromatograms from this method using SDE extract obtained from the roasted coffee of the present invention. The peaks are labeled 11 to 22 which correspond to 3-thiazole (11), 4-methylthiazole (12), peak 13 (13), peak 14 (14), peak 15 (15), tetrahydrothiophene (16), peak 17 (17), 2-thiophenecarboxaldehyde (18), peak 19 (19), 3-acetylthiophene, 2-acetylthiophene and peak 22.

The response factor is 1 for each of the burnt-rubbery compounds.

C) Analysis of Good Flavor Compounds

1) Analytical Method

Programmed temperature GC analysis is used to analyze the good flavor compounds. Sodium sulfate and an internal standard are added to a brewed coffee inside a closed system and heated. A headspace sample from the heated combination is injected into a Varian model 3400 Gas Chromatograph (DB-1701 column, 30 meter length, 0.32mm internal column diameter, from J&W Scientific of Folsom, California). The column contains a film of crosslinked polyethylene glycols 1.0um thick.

2) Application of Analytical Method

Sodium sulfate (13.00 ± 0.03 grams) is placed in a 120cc septum bottle. A roast and ground coffee sample (13.00 ± 0.01 grams) is added to the bottle followed by de-ionized water (65ml) and internal standard (1ml).

The internal standard is made by the following operation. A 1000cc volumetric flask is filled with distilled water to within 5-10 cm of the 1000cc calibration mark. With a pipet, 1ml of regent grade ethyl acetate is added to the flask. The ethyl acetate should be dispensed into the flask by lowering the tip of the pipet just below the surface of the water and tipping the flask (and pipet) slightly so that when the ethyl acetate is released, the droplets will rise to the

surface free of the pipet. When the ethyl acetate has stopped flowing, the pipet is raised inside the flask neck and the final few drops are "tipped off." The flask is stoppered, inverted, and agitated by swirling and inverting it 5-10 times. Agitation is stopped and the air bubbles are allowed to rise. Distilled water is added to make 1000ml. The liquid is again agitated. The resulting internal standard within the flask contains 1000 ppm (v/v) ethyl acetate.

After adding the internal standard, the bottle is sealed with a septum. A 2cc gas syringe and the sealed bottle are placed into a Blue M oven (Model SW-11TA) for 45 minutes at 90°C. The bottle is removed from the oven. A needle attached to the heated syringe is inserted through the septum to a level halfway between the top of the bottle and the surface of the liquid therein. Headspace (2ml) is removed and injected into the gas chromatograph.

The initial temperature of the column oven is 100°C for 5 minutes, raised 4°C/minute to 115°C and then held for 7 minutes, and finally raised 7°C/min. to 200°C and then held for 2 minutes.

GC conditions are:

Carrier gas: helium -- 2.5 cc/min.
Injection port temperature: 646°F (240°C)
Flame ionization detector:
Temperature: 482°F (250°C)
Hydrogen flow rate: 30 cc/min.
Air flow rate: 300 cc/min.
Chart speed: 0.5 cm./min.

The chromatogram analysis is the same as that used in the analysis of flavor strength and good flavor compounds.

Figure 5 is a gas chromatogram of this method using extract derived from roasted coffee from the present invention. The peaks are labeled 1 to 6 which correspond to ethanal (1), propanal (2), 2-pentanone (3), 3-pentanone (4) and 2,3-pentanedione (5).

In calculating corrected GC counts, the response factors include ethanal (71.59801), propanal (29.16200), 2-pentanone (18.42800), 3-pentanone (15.77300) and 2,3-pentanedione (41.89000).

C) Measuring Acidity

Brewed acidity index relates to the acidity of brewed coffee. Brewed coffee typically has a pH of from about 4 to 5. The brewed acidity index is a more discriminating acidity scale than logarithmic based pH units.

The brewed acidity index = 1000 x volume (ml) of 0.1 Normal sodium hydroxide added to 150 grams of coffee brew to raise its pH to 7.00. The coffee brew is prepared from 31.2 grams of roasted coffee particles and 1420ml of distilled water in a conventional automatic drip coffeemaker.

EXAMPLES

Preparation and characteristics of the high-yield, balanced-flavor coffee is illustrated by the following examples.

A) Example 1

Batch A (dark roasted dried beans): 100% green robusta coffee beans with an 11% moisture content are dried at 170°F (77°C) for 6 hours to a 5% moisture content. The dried beans are fast roasted in a Thermalo roaster, Model Number 23R using 45kg (100 lb) batches. The gas burner input rate is 1.7 million Btu/hr (498 kW). The roasting time is 130 seconds. The roasted beans have a Hunter L-color of 15 and a tamped density of 0.31 grams/cc.

Batch B (roasted non-dried beans): A blend of green coffee beans (50% washed Arabica, 50% natural Arabicas) with an 11% moisture content are fast roasted in a Thermalo roster using 45kg (100 lb) batches. The gas burner input rate is 1.4 million Btu/hr (410kW). Roasting time is 165 seconds. The roasted beans have a Hunter L-color of 18 and a tamped density of 0.36 grams/cc.

A 20:80 blend (Batch A to Batch B) is cracked, normalized, ground and flaked to an average flake thickness of 127um (0.005 inches). Roasted beans from Batch B are ground to an average particle size of about 1000um. The ground coffee is admixed with the coffee flakes in a 1:1 weight ratio. The brewed acidity index is 2800. f(1) is 1046, f(2) is 2100 and f(3) is 149.

B) Example 2

Batch A (dark roasted dried beans): 100% green robusta coffee beans with an 11% moisture content are dried at 170°F (77°C) for 6 hours to a 5% moisture content. The dried beans are fast roasted in a Thermalo roaster using 45kg (100 lb) batches. The gas burner input rate is 1.7 million Btu/hr (498 kW). The roasting time is 120 seconds. The roasted beans have a Hunter L-color of 17 and a tamped density of 0.31 grams/cc.

Batch B (roasted non-dried beans): A blend of green coffee beans (65% washed Arabica, 35% natural Arabicas) with an 11% moisture content are fast roasted in a Thermalo roster using 45kg (100 lb) batches. The gas burner input rate is 1.4 million Btu/hr (410kW). Roasting time is 165 seconds. The roasted beans have a Hunter L-color of 18 and a tamped density of 0.36 grams/cc.

A 29:71 blend (Batch A to Batch B) is cracked, normalized, and ground to an average particle diameter of 500um. The brewed acidity index is 2650. f(1) is 1139, f(2) is 1738 and f(3) is 211.

C) Example 3

Batch A (dark roasted dried beans): A blend of green coffee beans (50% washed Milds, 30% natural Arabicas, 20% Robustas) with an 11% moisture content are dried at 170°F (77°C) for 6 hours to a 5% moisture content. The dried beans are fast roasted in a Thermalo roaster using 45kg (100 lb) batches. The gas burner input rate is 1.7 million Btu/hr (498 kW). The roasting time is 120 seconds. The roasted beans have a Hunter L-color of 17 and a tamped density of 0.31 grams/cc.

Batch B (roasted non-dried beans): A blend of green coffee beans (50% washed Milds, 30% natural Arabicas, 20% Robustas) with an 11% moisture content are fast roasted in a Thermalo roster using 45kg (100 lb) batches. The gas burner input rate is 1.4 million Btu/hr (410kW). Roasting time is 165 seconds. The roasted beans have a Hunter L-color of 18 and a tamped density of 0.36 grams/cc.

A 5:95 blend (Batch A to Batch B) is ground to an average particle diameter of 900um. About 25% of the ground coffee is flaked to an average flake thickness of 127um (0.005 inches). The flakes are admixed with the remaining ground blended coffee. Tamped density is 0.37 grams/cc.

WHAT IS CLAIMED IS:

1. Process for making high-yield roasted coffee with balanced flavor, which comprises:

(a) drying green coffee beans, preferably green robusta coffee beans, prior to roasting to a moisture content of from 0.5 to 7%, preferably from 3 to 7% by weight, wherein the drying is conducted at a temperature of from 21° to 163°C for from 1 minute to 24 hours, preferably at a temperature of from 71° to 121°C for from 1 to 6 hours;

(b) roasting the dried beans from drying step (a) at a temperature of from 177° to 649°C for from 10 seconds to 5.5 minutes to a Hunter L-color of from 10 to 16,

(c) blending the dried roasted beans from roasting step (b) with non-dried coffee beans roasted to a Hunter L-color of from 17 to 24 and having a moisture content before roasting of greater than 7% by weight, wherein the blend comprises from 1 to 50%, preferably from 5 to 15% by weight of the dried roasted beans and from 50 to 99%, preferably 85 to 95% by weight of the non-dried roasted beans.

2. A process according to Claim 1 wherein the dried green coffee beans in roasting step (b) are roasted at a temperature of from 204° to 427°C for from 1 to 3 minutes.

3. A roasted coffee product comprising:

(a) from 1 to 50%, preferably from 5 to 15% by weight of dark roasted coffee made by the process comprising

(i) drying green coffee beans prior to roasting to a moisture content of from 0.5 to 7% by weight, wherein the drying is conducted at a temperature of from 21° to 163°C for from 1 minute to 24 hours;

(ii) roasting the dried beans from step (a)(i) at a temperature of from 177° to 649°C for from 10 seconds to 5.5 minutes to a Hunter L-color of from 10 to 16;

(b) from 50 to 99%, preferably from 85 to 95% by weight of coffee roasted to a Hunter L-color of from 17 to 24 and derived from green coffee beans having a moisture content prior to roasting of greater than 7%;

(c) wherein the roasted coffee product has an f(1) value greater than 900, an f(2) value greater than 1200, and an f(3) value greater than 125, where

f(1) = 10,000 x [pyrazine + pyridine + pyrrole + guaiacol + ethyl guaiacol] / [3-thiazole + 4-methylthiazole + peak 13 + peak 14 + peak 15 + tetrahydothiophene + peak 17 + 2-thiophenecarboxaldehyde + peak 19 + 3-acetylthiophene + 2-acetylthiophene + peak 22], f(2)= 100 x [ethyl guaiacol], and f(3) = 100 x [ethanal + propanal + 2-pentanone + 3-pentanone + 2,3-pentanedione] / [pyrazine + pyridine + pyrrole + guaiacol + ethyl guaiacol]; and

(d) wherein the brewed acidity index is greater than 2200, where brewed acidity index = 1000 x volume (ml) of 0.1 Normal sodium hydroxide added to 150 grams of coffee brew to adjust the pH of the brew to 7.00.

4. A coffee product according to Claim 3 wherein the dark roasted coffee from (a) is derived from robusta coffee beans.

5. A coffee product according to Claim 3 wherein the roasting in step (a)(ii) is conducted at a temperature of from 204° to 427°C for from 1 to 3 minutes.

6. A coffee product according to Claim 3 wherein the drying in step (a)(ii) is conducted at a temperature of from 71° to 121°C for from 1 to 6 hours.

7. A coffee product according to Claim 3 wherein the green coffee beans are dried in step (a)(ii) to a moisture content of from 3 to 7% by weight.

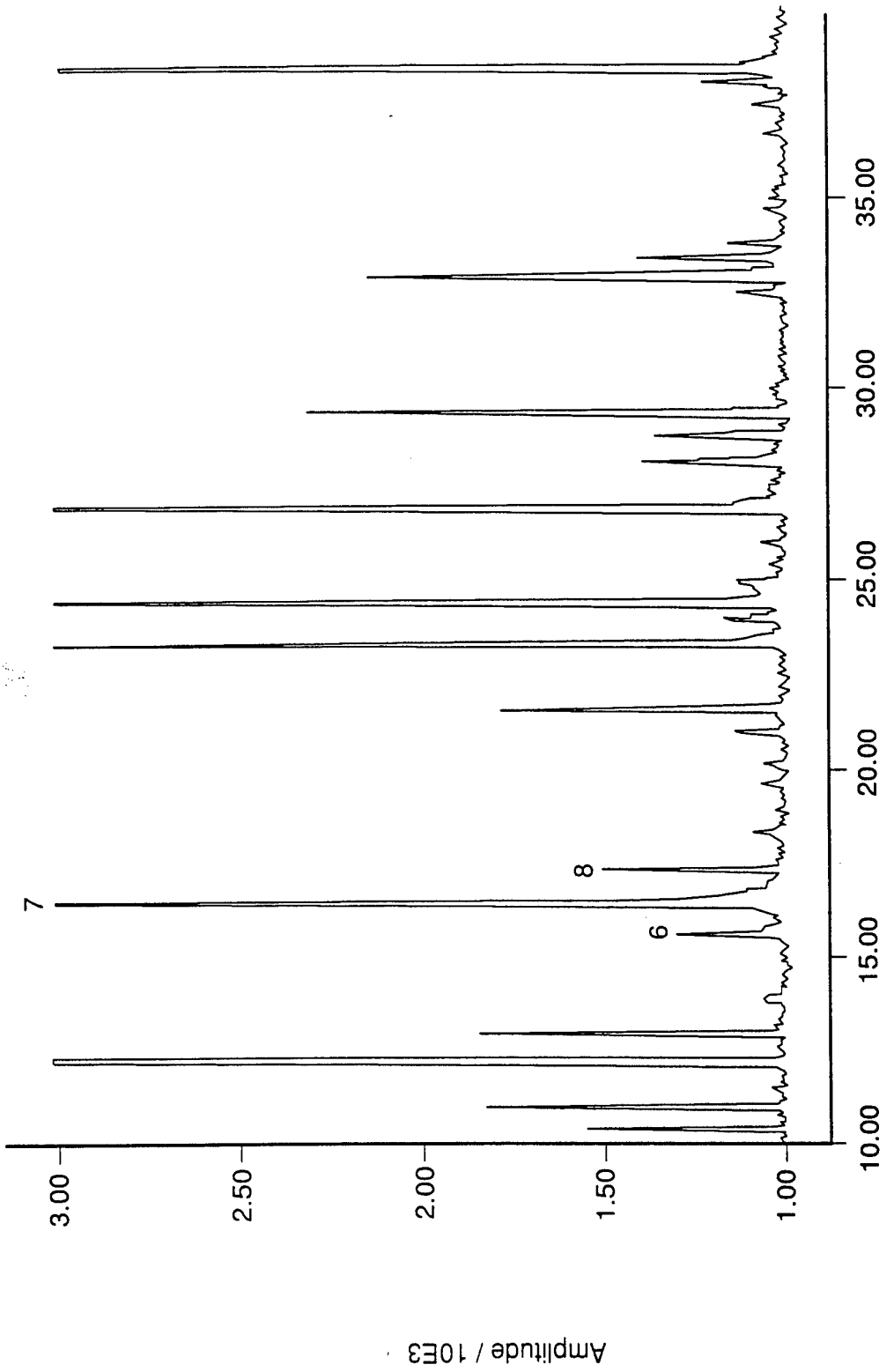

Amplitude / 10E3
3.00
2.50
2.00
1.50
1.00
10.00
15.00
20.00
25.00
30.00
35.00
Retention time in minutes
7
8
6

Fig. 1

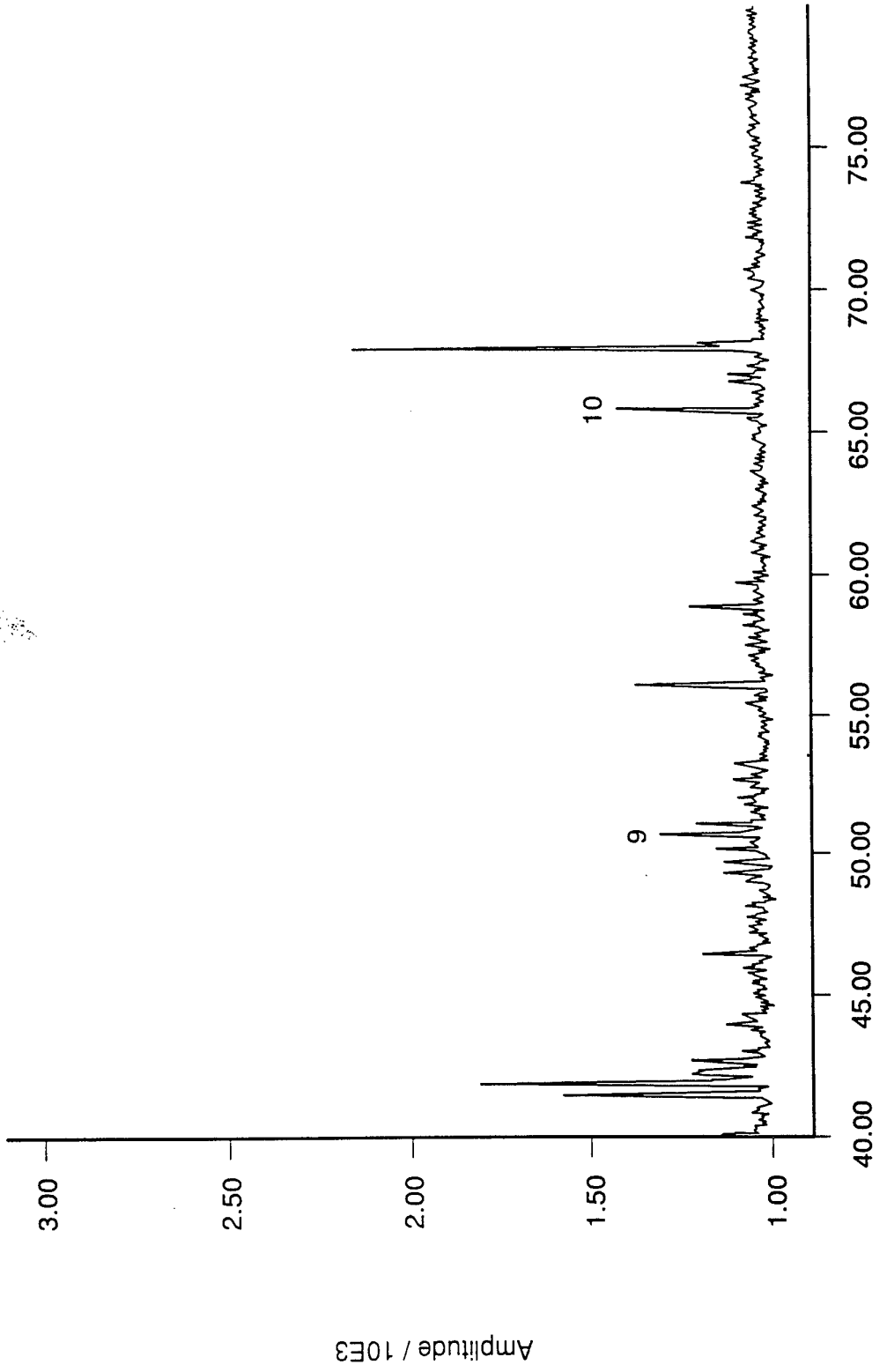

Amplitude / 10E3
3.00
2.50
2.00
1.50
1.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
Retention time in minutes
9
10

Fig. 2

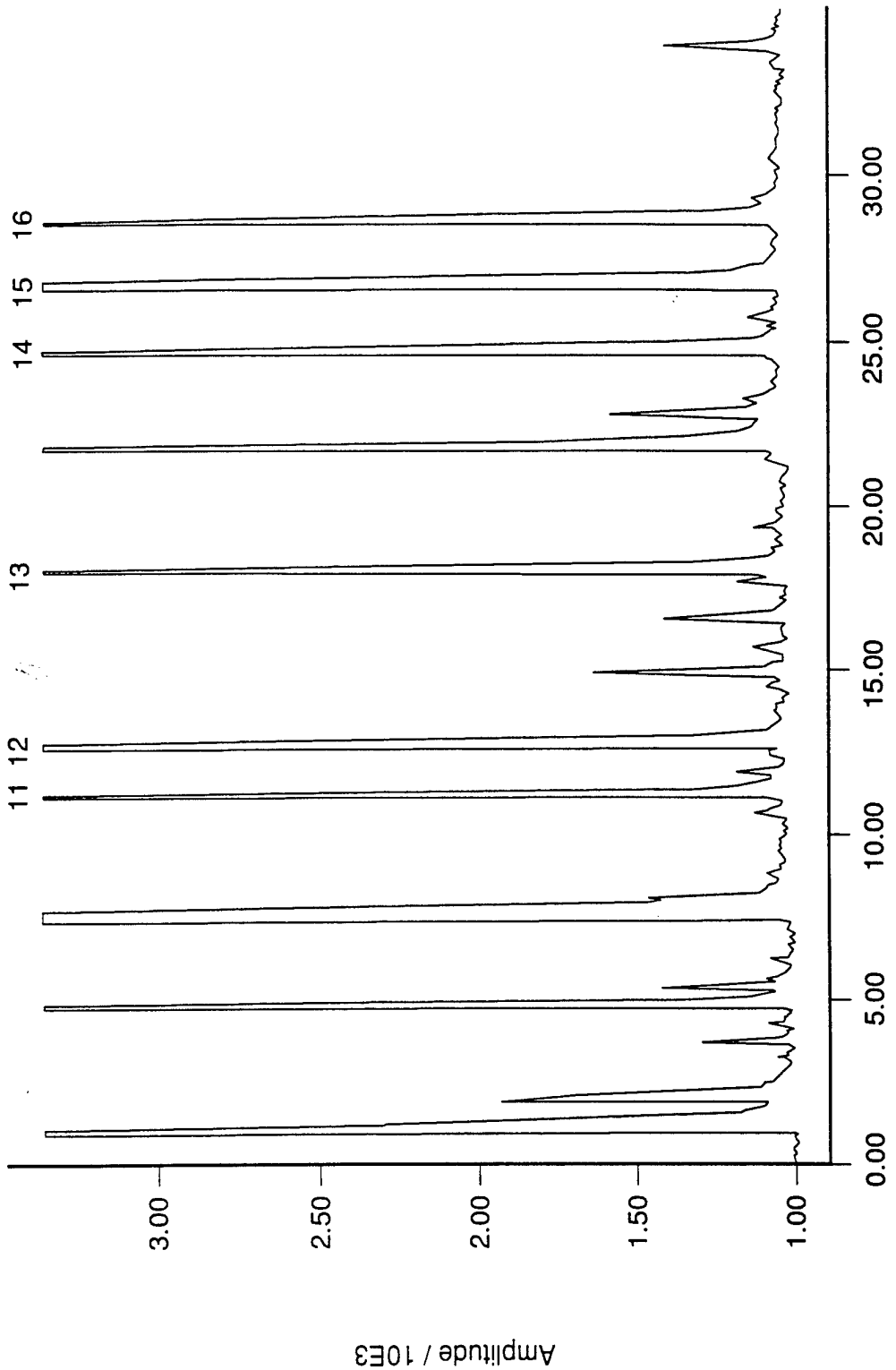

Amplitude / 10E3
3.00
2.50
2.00
1.50
1.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Retention time in minutes
11
12
13
14
15
16

Fig. 3

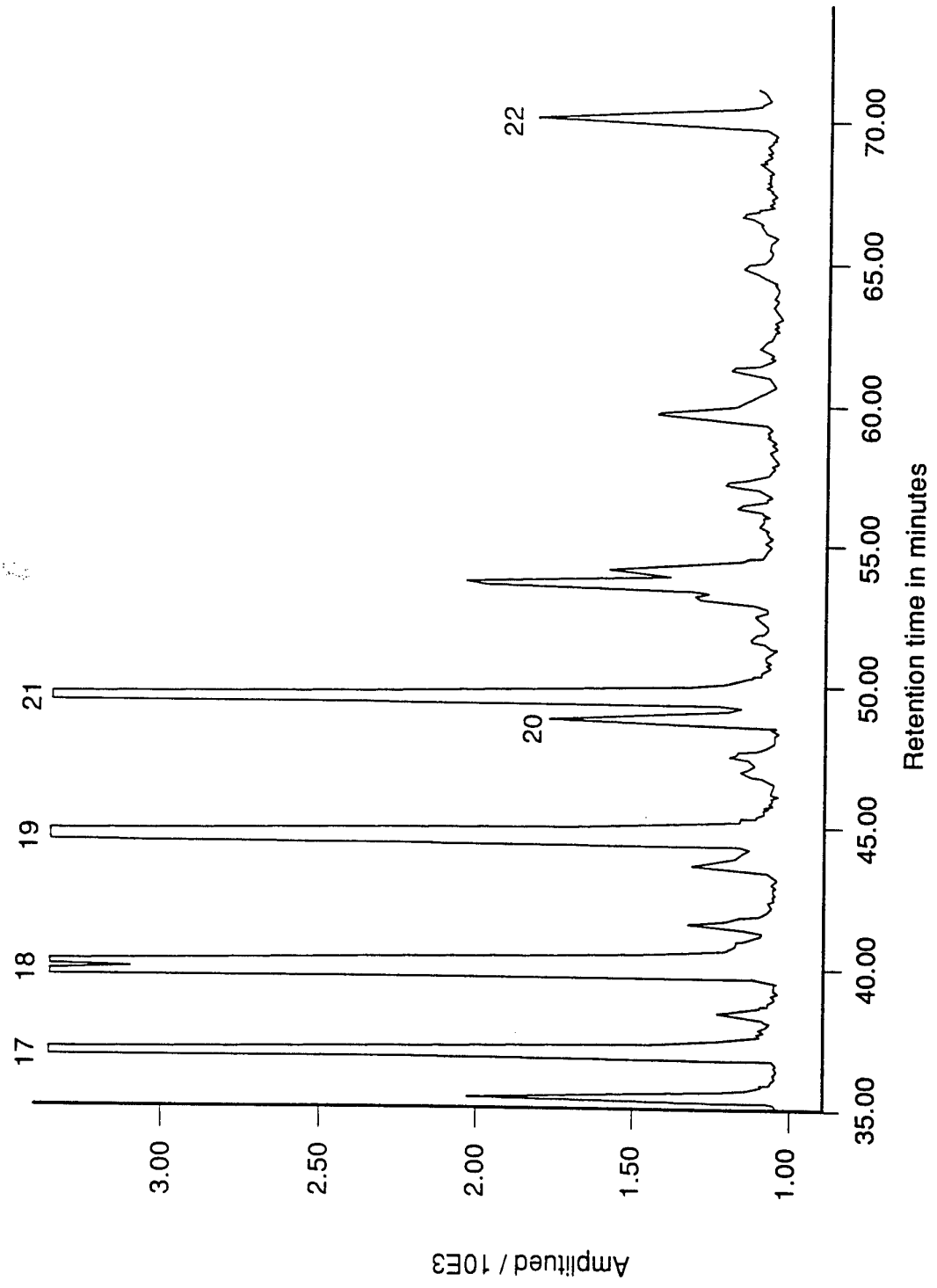

Amplitued / 10E3
3.00
2.50
2.00
1.50
1.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
Retention time in minutes
17
18
19
20
21
22

Fig. 4

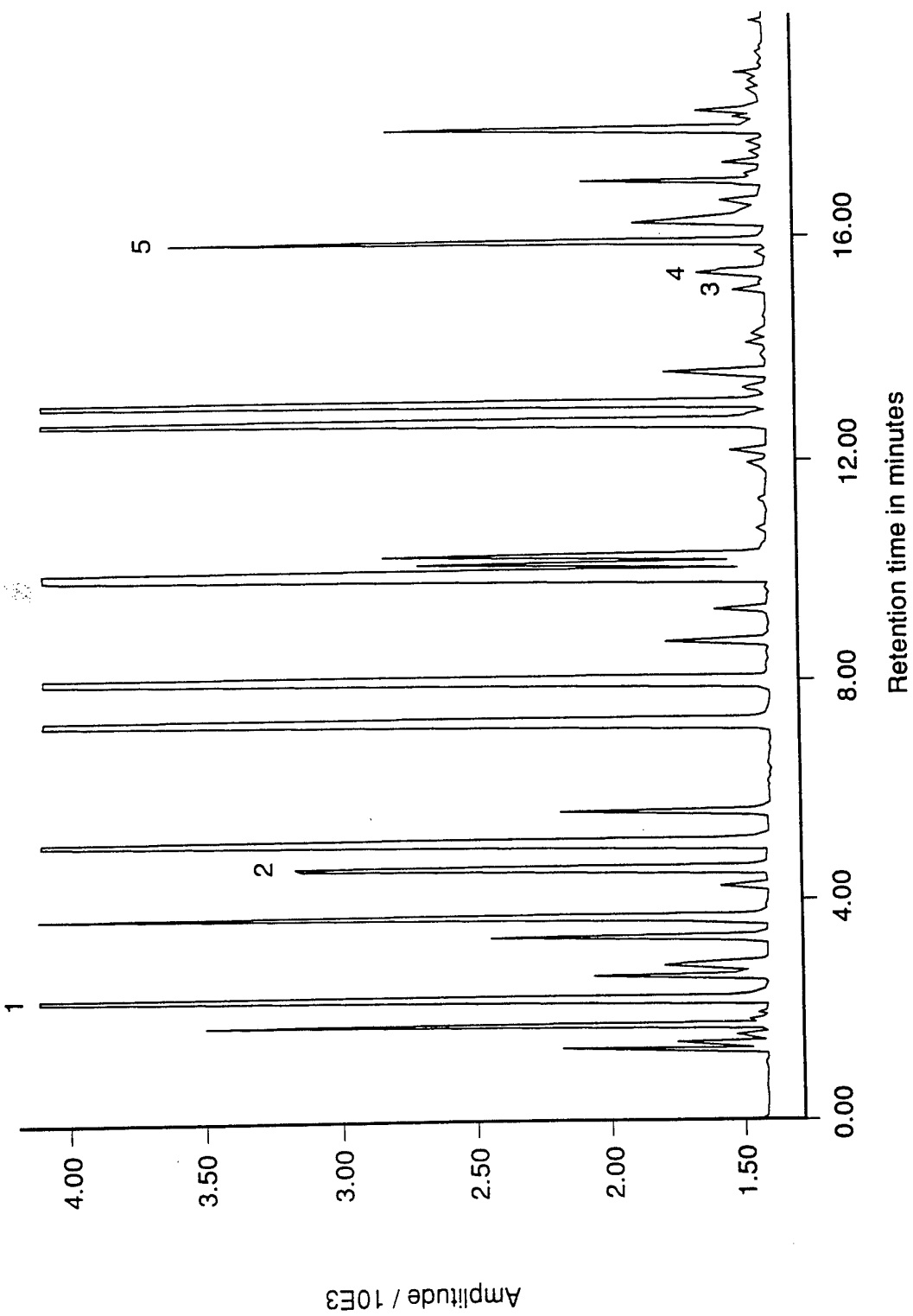

Amplitude / 10E3
4.00
3.50
3.00
2.50
2.00
1.50
0.00
4.00
8.00
12.00
16.00
Retention time in minutes
1
2
3
4
5

Fig. 5

INTERNATIONAL SEARCH REPORT

Interr al Application No
PCT/US 93/11476

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A23F5/04 A23F5/12 A23F5/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A23F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,5 227 188 (J. LEPPLA ET AL.) 13 July 1993 see column 5, line 441 - line 46; example 1	1-7
A	EP,A,0 405 648 (THE PROCTER & GAMBLE CO) 2 January 1991 see claims 1-10	1
A	EP,A,0 405 649 (THE PROCTER & GAMBLE CO) 2 January 1991 see claims 1-10	1
A	US,A,3 589 912 (I. ADLER ET AL.) 29 June 1971 see claims 1-5; example	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 May 1994	27.05.94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	Desmedt, G

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

information on patent family members

Interr al Application No
PCT/US 93/11476

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-5227188	13-07-93	CA-A-	2105037	11-03-94
EP-A-0405648	02-01-91	AU-A-	5805390	03-01-91
		CA-A-	2017744	31-12-90
		JP-A-	3216153	24-09-91
		US-A-	5160757	03-11-92
EP-A-0405649	02-01-91	AU-A-	5805290	03-01-91
		CA-A-	2018210	31-12-90
		JP-A-	3216152	24-09-91
US-A-3589912	29-06-71	NONE		