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ASSESSMENT OF AROMA OF CHOCOLATE PRODUCED FROM TWO GHANAIAN COCOA FERMENTATION TYPES

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Abstract

Chocolates produced from two cocoa fermentation types (heap‘ and tray‘) were analysed by GC-MS and GC-O to identify and detect important odorants. The most important odour in both types of chocolate was identified as 2/3-methyl butanal with a cocoa/chocolate attribute. One odour described as grassy/lettuce and which seemed to be important for the aroma of both types of chocolates remained unidentified. Two acids, 3-methyl butanoic acid with an unpleasant blue cheese odour and acetic acid with a sharp, vinegar odour were also identified as key odorants in the two types of chocolates. Differences were identified in the types of odorants important in the two types of chocolate and these are expected to cause sensory differences between the two types of chocolate.

Introduction

The aroma of chocolate is one of its most important characteristics that determine quality. The fermentation of cocoa is critical for the formation of precursors that develops the characteristic chocolate aroma in roasted beans. The aroma and flavour of cocoa depends on the genotype of the cocoa tree that has produced the beans, the origin, and how the beans have been fermented (1, 2). Most Ghanaian farmers practise the traditional heap fermentation method (3). This is a method where upon breaking of the pod, the beans are piled on and covered by banana leaves. The heaps differ in size and may range from 20 to 1000 kg. Big heaps have to be turned once every 24-72 hours to achieve even fermentation but this is not adhered to by most Ghanaian farmers because of the tediousness involved (3). Another fermentation method developed by the Cocoa Research Institute of Ghana (CRIG) is the Tray system which involves fermenting the beans in 10 cm deep wooden trays. Eight to ten trays are stacked on top of each other and the top-most tray is covered with banana leaves. This method allows aeration of the fermenting mass without having to turn and ensures better and more even fermentation (3). Efforts are being made to encourage cocoa farmers in Ghana to adopt the tray system to improve the quality of fermented beans. This investigation aims to assess the chemical basis for differences between the aroma of chocolate produced from Ghanaian cocoa beans fermented by the above mentioned methods: heap and tray.

Experimental

Chocolate samples. Heap- and tray-fermented cocoa beans, grown and fermented in Ghana, were used for the manufacture of dark chocolate at Toms Confectionery

Group A/S, Denmark, using the same recipe. The ingredients used in the production of the dark chocolate were sugar, cocoa beans, cocoa butter and lecithin as emulsifier.

Dynamic headspace sampling and GC-MS. Dynamic headspace sampling using Tenax traps and thermal desorption is described in a lot of studies (4, 5). The technique was optimised by using 20 g of sample and purging with a nitrogen flow of 200 mL/min for 1 h at 30°C. The volatiles were analysed using GC-MS (4, 5).

GC-O. GC-O analysis was performed by three trained judges who evaluated both chocolates using the method described in (4).

Results

GC-MS identified 64 volatile aroma components in 'heap' chocolate and 58 in 'tray' chocolate. These included alcohols, acids, aldehydes, esters, furans, ketones, pyrazines, a pyrrole and a sulphur compound (Table 1). Although similar compounds have been reported by earlier workers in chocolate and other cocoa products, differences exist in the reported number of aroma compounds identified in these products. Cournet et al. 2004 identified more pyrazine-type compounds, for instance, in dark chocolate than was identified in the present study. Such differences may stem from the genotype of cocoa used, the fermentation/drying method and the manufacturing process. In the case of chocolate, the most important processes being the degree of roasting of the cocoa beans and conching of the chocolate and the ingredients used.

Peak areas of isoamylacetate, linalool and methyl phenyl acetate were significantly different ($p<0.05$) for the two types of chocolate, whilst 2-acetylcyclopentanone, furfural, furfuryl alcohol, 1-(2-hydroxyphenyl)-ethanone and o-methoxyphenol were detected in only 'heap' chocolate.

Twenty-three odours were detected by GC-O analysis of 'heap' chocolates and 24 odours in 'tray' chocolates, three of them in each type of chocolate still unknown. Of these, 15 odours in 'heap' chocolate and 19 odours in 'tray' chocolate seemed important as they were detected by all three judges and these included one unknown with a grassy, lettuce attribute in both types of chocolates. The most important odorant, in both types of chocolate, based on the summed duration in minutes that the odorant was detected by the judges, was a peak described as having a chocolate or cocoa odour and identified as a non separable mixture of 2- and 3-methylbutanal. This has also been reported by some earlier workers (1, 2, 6).

Four odorants were detected as important in 'heap' chocolate alone whilst 7 odorants were detected as important in 'tray' chocolate alone. These odorants included pyrazines and the aldehydes, most of which are derived during the chocolate production process but others such as the alcohols and acids are products of fermentation which have persisted in the chocolate (7). The acids seemed rather abundant in both types of chocolate; 3-methyl butanoic acid, with an unpleasant blue cheese odour, and acetic acid with a sharp, vinegar odour, also seemed to be major contributors to the aroma of both types of chocolates. Linalool, detected as a key odorant in 'tray' chocolate alone is known to give a flowery tea-like odour to cocoa and is related to the fermentation method (7).

Differences in key odorants are expected to result in sensory differences between chocolate produced from heap- and tray-fermented cocoa beans. Further work is underway to do a sensory evaluation of the chocolates using a trained sensory panel to relate sensory measurements to instrumental measurements.

Table 1. *Aroma components of chocolate produced from heap- and tray-fermented cocoa beans.*

Compound	Identification[a]	Description of odour	Peak area[b] x10^3	
			'heap'	'tray'
2/3-Methylbutanal	MS, GC-O, S	cocoa, chocolate	438	512
2,3-Butanedione	MS, GC-O, S	caramel, sweet	327	201
Hexanal	MS, S		59	86
Isoamylacetate	MS		388*	95*
2-Pentanol	MS, S		107	79
2-Heptanone	MS, S		88	64
Heptanal	MS, S		17	18
2/3-Methyl butanol	MS, S		45	26
2-Pentyl furan	MS, S		82	95
1-Pentanol	MS, S		94	53
Methylpyrazine	MS		48	35
3-Hydroxy-2-butanone	MS, GC-O	fruity	365	220
2-Octanone	MS		60	58
Octanal	MS, GC-O, S	orange, soapy	30	22
2,5-Dimethylpyrazine[d]	MS, GC-O, S	earthy, mushroom	104	76
2,6-Dimethylpyrazine	MS		64	54
2-Decanol	MS		51	24
Ethylpyrazine[d]	MS, GC-O	popcorn	22	16
2-Acetylcyclopentanone	MS		43	-
2,3-Dimethylpyrazine[c]	MS, GC-O	popcorn, potato	61	37
Dimethyl trisulphide	MS, GC-O, S	unpleasant, sharp	12	10
2-Ethyl-6-methylpyrazine	MS		37	25
2-Nonanone	MS, GC-O, S	alcohol	72	43
Nonanal	MS, GC-O, S	fresh, fruity	120	113
2,3,5-Trimethylpyrazine	MS, GC-O	earthy, grass	388	166
Unknown 1	GC-O	sharp, liquorice	n.d.	n.d.
Unknown 2	GC-O	grass, lettuce	n.d.	n.d.
Ethyl octanoate	MS, S		29	26
Acetic acid	MS, GC-O, S	vinegar, sharp	3596	4686
Furfural	MS, S		37	-
2,5(or 6)-Dimethyl-3-ethylpyrazine	MS, GC-O, S	potato, earthy	35	21
Linalool oxide	MS, S		34	20
Tetramethylpyrazine	MS, GC-O	potato, earthy	2393	1042
2-Acetylfuran	MS, GC-O, S	sharp, rubber	26	14
2-Decanone	MS		9	23
Benzaldehyde[d]	MS, GC-O, S	vegetable, grass	359	267
2,3,5-Trimethyl-6-ethylpyrazine[c]	MS, GC-O	grass, paprika	39	14
Propanoic acid	MS, S		31	21
Linalool[d]	MS, GC-O	flowery, fruity	16*	47*

Table 1. cont'd.

Compound	Identification[a]	Description odour	Peak area[b] x 10^3	
			'heap'	'tray'
2-Methyl propanoic acid	MS		1135	518
1,3/2,3-Butanediol	MS		1945	1746
Dihydro-2(3H)-furanone	MS		79	55
Butanoic acid	MS, S		68	47
Phenylacetaldehyde[d]	MS, GC-O	cocoa	132	121
1-Phenyl ethanone	MS, GC-O	flowery, sweet	137	70
Furfuryl alcohol[c]	MS, GC-O, S	oat	14	-
3-Methyl butanoic acid	MS, GC-O, S	unpleasant, blue cheese	1453	912
3-Methyl-2-heptanone	MS		-	10
Benzyl acetate[d]	MS, GC-O, S	liquorice	14	9
Methyl phenylacetate	MS		29*	8*
Epoxylinalol	MS, GC-O	sweet, flowery	34	18
Ethyl phenylacetate	MS, GC-O, S	flowery, rose	133	255
1-(2-Hydroxyphenyl)-ethanone	MS		16	-
1-Phenylethanol	MS		44	19
Phenethyl acetate	MS, GC-O, S		775	667
1-Butanol-3-methyl benzoate	MS		214	93
Hexanoic acid[d]	MS, GC-O, S	sharp, spicy	131	108
Butoxyethoxy ethylacetate	MS		31	32
o-Methoxyphenol	MS, S		53	-
Benzyl alcohol[c]	MS		61	214
Unknown 3	GC-O	sweet, vanilla	n.d.	n.d.
2-Phenethyl alcohol	MS, GC-O, S	flowery, rose	881	324
2-Phenyl-2-butenal	MS		30	16
Heptanoic acid	MS, S		131	108
2-Acetylpyrrole	MS		63	59
Phenol	MS		71	28

[a] Identification by (MS) mass spectra, (GC-O) Gas Chromatography-Olfactometry and S, standard compound; [b] mean of five replicates; [c] key odorant in 'heap' chocolate alone; [d] key odorant in 'tray' chocolate alone; * significant difference at p<0.05; n.d., not determined; -, not detected.

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