THE EFFECTS OF TAPIOCA STARCH AND OAT FIBRE ON SELECTED FLAVOUR VOLATILES OF LOW-FAT BEEF BURGERS.

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BACKGROUND

Fat level effects the overall acceptability of meat products. However, the effects of fat level on flavour *per se* are not well established and if there are flavour effects these maybe confounded by the more obvious effects of fat on the textural properties of meat products. A number of researchers (Troutt *et al.* 1992; Kregel *et al.* 1986; Berry and Leddy, 1984) found no significant effect of fat level on flavour intensity at fat levels in the range 10-30% but Troutt *et al.* (1992) reported a reduction in beef flavour when the fat content was reduced to 5% in beef burgers. Nevertheless, it is clear the lipids make a significant contribution to the flavour of meat products although this remains to be defined. Lipid reactions are believed to contribute ~90% of the flavour volatiles in meat (Reineccius, 1994). It appears that it is the phospholipid fraction that contributes substantially to basic "meaty" flavour (Farmer and Mottram, 1990; Mottram and Edwards, 1983). In this context, the flavour problems associated with low-fat meat products may not be due so much to the absence of specific flavour precursors as to the loss of the physical characteristics of the fat. To date various fat replacers have found application in low-fat products to improve their overall quality. Among the problems associated with using fat replacers are: (i) a decrease in meat flavour due to dilution by non-meat ingredients; (ii) a decrease in the formation of flavour compounds between indigenous meat components; and (iii) development of flavours specific to the fat replacers themselves.

OBJECTIVE

The aim of this work was to identify volatile compounds in comminuted meat which would act as "indicator compounds" to demonstrate how different compound classes are affected (if at all) by the fat content and/or by the addition of ingredients such as tapioca starch and oat fibre. The objective being to examine the difference in volatiles between full-fat (23 %) and low-fat (10%) and the effects when tapioca starch and oat fibre were added to the low-fat formulations.

METHODS

Beef Burger Manufacture: Lean beef (90-95%VL) forequarter was coarsely ground through a 10mm plate. Beef burgers were formulated with 2.5% tapioca starch and 1.0% oat fibre. The meat and the non-meat ingredients were then mixed and minced through a 5mm plate. Once formed the beef burgers (113g) were stacked four high and immediately blast frozen at -20°C overnight. Once frozen they were vac-packed and stored at -20°C until required.

Dynamic Headspace Analysis: The volatile compounds from the cooked beef burgers were collected in glass-lined stainless steel traps containing 2.6mg Tenax GC. The odour volatiles were then collected by dynamic headspace concentration. GC-MS analysis was performed to separate and identify the volatiles. Compounds from the resulting chromatograms were identified by computer-matching of a mass spectral database and by comparison of the linear retention indices (LRI) values with those of authentic compounds. Peaks were then semi-quantified which entailed peaks integrated over a certain ion specific to the compound been analysed. An internal standard of bromobenzene was also used.

RESULTS AND DISCUSSION

The headspace samples from each type of beef burger contained several hundred volatile components. Most of these compounds have been reported previously as volatile components of cooked beef (Maarse and Visscher, 1989). The volatiles were selected and positively identified, for their abundance and because the peaks appeared to change between treatments. Hydrocarbons, aldehydes, alcohols, ketones, benzene derivatives, hetrocyclic compounds and sulphur-containing compounds were detected in all beef burger formulations (Table 1). The headspace volatiles of the beef burgers both high- and low-fat were dominated by saturated straight chain aldehydes and alcohols. These oxygenated compounds arise principally from the thermal oxidative degradation of unsaturated lipids (Farmer, 1992). Linoleic acid is one of the main unsaturated fatty acid moieties of lipids and it has been shown to undergo thermal oxidative decomposition to give a range of products including hexanal, 1-octen-3-ol and 1-pentanol (Mottram and Edwards, 1983).

The profile of volatiles contained in the headspace of the beef burgers seems to be affected by fat content. The relatively small differences between the volatile profile of the full-fat and low-fat controls is in agreement with previous studies on the role of lipids in the formation of meat flavour. Mottram and Edwards (1983) demonstrated that all the triglycerides could be removed from beef without altering the "meaty" character of the odour; however, removal of structural phospholipids as well resulted in the odour becoming "roasted" and "toasted" rather than "meaty" in character. In addition, the removal of the triglycerides had little effect on the pattern of volatile compounds, while the removal of phospholipids caused major changes. Similar results have been obtained from model systems (Farmer and Mottram, 1990). Thus, the main finding of this study is that there is no major difference in flavour volatiles from full- and low-fat beef burgers. The main difference is due to the quantities of some volatiles released. This is despite reports (Moody, 1983; Goutefongea and Dumont, 1990; Mela, 1992) which state that the reduction of fat has an adverse effect on sensory flavour perception in low-fat meat products. From these results it can be postulated that lean meat has a pool of phospholipids for the requirements of flavour formation. This pool is contained in both full- and low-fat meat products. Farmer (1992) reported that both subcutaneous or intramuscular fats do not contain impotant flavour volatiles. These fats contain triglycerides which have little effect on meat aroma formation. Mottram and Edwards, 1983 reported that the removal of triglycerides had little effect on the flavour of meat. Thus, it appears that there is sufficient lipid in the structural phospholipids for meat flavour formation. These results indicate that the main effect of fat on flavour is the release of flavour compounds in the mouth.

The occurrence of compounds does not differ substantially between all the treatments. These results are not surprising given the similarities in pattern of volatiles between the high- and low-fat beef burgers. Statistical analysis (Table 1) shows there was a clear differences ($P<0.05$) between the low-fat, the control and ingredient formulations, and high-fat treatments for some of the volatile compounds released, in particular, between the beef burgers containing tapioca starch and oat fibre. Very few differences ($P>0.05$) were found between the high- and low-fat controls except for 1-octen-3-ol, 2-ethyl-1-hexanol and 2-pentyl furan. There were higher peak intensities for volatiles in the tapioca beef burger that were significantly different compared to the oat fibre beef burger. Interactions between starch and flavour components have been extensively investigated and it appears that the amylose part of starch is capable of forming inclusion complexes with various volatiles (Solms, 1986).

Consistent trends can be observed from the results; relative peak areas of volatile compounds in the headspace of beef burgers containing tapioca starch are similar to the relative peak areas of volatile compounds from the low-fat control. In contrast, the oat fibre results are closer to those obtained for the high-fat control beef burger; both these products show reduced headspace concentrations of volatile compounds overall and of specific compounds. The fact that all the compounds (lipid oxidation and Maillard or amino acid breakdown products) show a similar trend suggests that this may be due to physical effects rather than changes in chemical pathways. This may indicate that oat fibre is capable of binding flavour volatiles.

CONCLUSIONS

The profile of volatiles in the headspace of the beef burgers seems to be affected by fat content, however, the occurrence of the various compounds did not substantially differ between the different treatments. There were clear differences between intensities of the volatile compounds released, in particular between the low-fat beef burgers containing tapioca starch and oat fibre. The relative peak areas of volatile compounds in the headspace of beef burgers containing tapioca starch are similar to those of the low-fat control. In contrast, the oat fibre results are closer to those obtained for the high-fat control. Oat fibre may be capable of binding flavour volatiles due to the fact that all the compounds show a similar trend suggesting that this may be due to physical effects rather than changes in chemical pathways. It is considered probable that, while some effects on the release of volatiles in the headspace were observed the main effect of fat content on flavour is on the release of the flavour compounds in the mouth.

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TABLE 1: Selected volatiles (representative sample) identified in full- and low-fat beef burgers

Compound	Ion (a.m.u.)	LRI[d]	Peak Area[e]				Method of ID[f]
			HFC	LFC	Oat Fibre	Tapioca Starch	
hexanal	56	1092	3.02[a]	3.42[a]	2.64[a]	3.36[a]	MS + LRI
2-hexenal	69	1220	0.14[ab]	0.12[ab]	0.06[a]	0.16[b]	MS + LRI
2-octenal	41	1413	0.19[a]	0.29[ab]	0.15[a]	0.39[b]	MS + LRI
1-pentanol	70	1251	1.57[a]	1.35[a]	1.37[a]	1.31[a]	MS + LRI
1-octen-3-ol	72	1446	0.98[a]	1.71[b]	1.00[a]	1.76[b]	MS + LRI
2-ethyl-1-hexanol	83	1494	0.27[a]	1.59[b]	0.73a	2.43[c]	MS + LRI
2-heptanone	58	1189	1.01[a]	1.66[ab]	1.05[ab]	1.70[b]	MS + LRI
2-pentyl-furan	81	-	1.06[a]	2.15[c]	1.34[ab]	1.80[bc]	MS
dimethyl trisulphide	126	1356	0.10[a]	0.18[a]	0.09[a]	0.09[a]	MS + LRI

[a-c]Mean peak areas in same row with different letters are different ($P<0.05$), [d]LRI=Least Retention Indices, [e]Peak area relative to internal standard bromobenzene (ion 156), [f]MS=Mass spectrum agrees with literature spectrum; LRI=LRI agrees with LRI of authentic compound.