EFFECT OF GRINDING AND EXTRACTION TEMPERATURE ON RECOVERY AND QUALITY OF FAT FROM CHICKEN SKIN

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INTRODUCTION

The *per capita* consumption of poultry meat in Canada has increased by 50% in the last 20 years, to reach 30 kg/year in 1996. In the same time, consumers' habits have changed and most of the poultry is now sold portioned (55%) or further processed (31%), rather than as whole birds (14%; Anonyme, 1994). Consequently, the poultry processing industry generates ever increasing amounts of underutilized by-products, including chicken skin. As part of a comprehensive industry-government effort to find better uses for these by-products, the present study investigates the conditions required to recover high quality fat from the chicken skin currently sold for rendering. The data presented are a useful addition to the limited information available on chicken fat quality (Viau et Gandemer 1991ab; Gomes *et al.*, 1983; Pereira, 1976).

MATERIALS AND METHODS

Ground (9.5 mm plate) or homogenized (Stephan Mikrocut emulsifier; 0.2 mm knife set) chicken skin samples were heated in a steam-jacketed kettle to reach 50°C or 80°C. Following a 5 min holding time, the samples were filtered through a cheese cloth to eliminate the remaining solid skin pieces, and the liquid phase was centrifuged to separate fat from water. The recovered fat was subsequently vacuum-packed, frozen, and kept at -40°C prior to being analyzed for quality. Characteristics evaluated included insoluble contents (AOCS Ca3-46), insaponifiables (AOCS Ca6a-40), APC (pour plate on PCA agar, 32°C incubation), residual water (Karl-Fisher method), colour of solid fat (L*a*b*, D65 lighting), peroxide index (PI; AOCSCd8-53), resistance to oxidation (time to reach a PI of 10 at 70°C; Schall oven test), PI after 2 months at 23°C, free fatty acids (FFA as oleic acid; AOCS Ca5a-40), lipolytic activity (evolution of FFA during 2 months at 23°C, with or without added lipase). In addition, fat recovery was evaluated by calculating the processing yield (100 x fat recovered / skin processed) and the % fat extracted (100 x fat recovered / total fat in skin).

RESULTS AND DISCUSSION

Both the processing yield and the percentage of fat recovered from ground chicken skin (9.5 mm) increased considerably when extraction was performed at 80°C rather than at 50°C (Figure 1). A further increase in recovery was obtained when homogenized skin (0.2 mm) was used instead of ground skin. In that case, using the highest temperature for extraction (80°C) offered little benefit in terms of fat recovery (89.9 ± 2.9% of total fat, instead of 87.8 ± 1.6% at 50°C).

In general, only slight differences were found between fats corresponding to the different treatment combinations (0.2 mm x 50°C; 0.2 mm x 80°C; 9.5 mm x 50°C; 9.5 mm x 80°C), with the exception of insaponifiable contents and oxidation status (Table 1).

Irrespective of the extraction temperature, fats recovered from finely homogenized skin (0.2 mm) contained about twice as much insaponifiable (fat soluble) impurities (0.17-0.21%) as the fats recovered from ground skin (0.08%; Table 1). The insaponifiable impurities are believed to consist of fat soluble substances, including tocopherol (vitamin E), carotenoids, and possibly cholesterol, initially present in the adipocyte cell membranes. Fine homogenization of the skin prior to heating would logically result in considerable disruption of the cell membranes, with concommittent transfer of their fat soluble components to the cytoplasmic fat droplets. This hypothesis is presently being tested by actual analyses of tocopherols, carotenoids, and cholesterol.

Regardless of the degree of comminution, the peroxide index of recovered fats increased with increasing extraction temperatures (Table 1), from 0.78-0.85 in fats extracted at 50°C to 0.93-0.98 in fats extracted at 80°C. In addition, fats recovered from finely homogenized skin were found to have a better resistance to oxidation (79-87 h to reach a PI of 10 at 70°C; Table 1) than fats extracted from coarser skin preparations (66-70 h), leading to a lower degree of oxidation after two months of storage at room temperature (PI = 1.19-1.79, instead of 2.05-2.30 for fats from ground skin). The higher resistance to oxidation of fats extracted from finely homonenized skin is consistent with the hypothesis of a higher content in tocopherol which has anti-oxidant properties.

One was concerned that extracting fat at a lower temperature than generally used in rendering operations could result in higher bacterial loads, leading to shorter storage life and possibly safety risks. However, fats extracted at 50°C did not contain substantially more bacteria than fats extracted at 80°C (Table 2). The low bacterial charge in fats extracted from mildly heated (50°C) ground skin was unexpected and is probably due to a combination of two causes. Firstly, the ground chicken skin actually remained for about 110 min between 40°C and 50°C prior to analysis, when heating and holding times were combined, and this may have been enough to inactivate most of the bacteria initially present in the skin, considering that these were almost exclusively psychrotrophic, due to refrigeration

during slaughter and further processing. Secondly most bacteria present in food being hydrophilic in nature, they would tend to remain in the water phase at the time of fat separation. It must be stressed, however, that the results of the study do not mean that extracting fat at low temperature does not present a health risk, since the presence of pathogens was not investigated.

One was also concerned about the possibility of increased hydrolysis in fats extracted at low temperature (50°C), due to improper destruction of the lipolytic enzymes initially contained in chicken skin. However, lipolytic activity was never detected after fat extraction, even at 50°C (Table 1). Also, fats extracted at low temperature had the same FFA (free fatty acids) contents as the fat extracted at higher temperature, both right after extraction and after two months of storage at room temperature. Therefore, either the endogenous lipases were eliminated during the fat/skin separation process, or the duration of the heat treatment was sufficient to inactivate them.

CONCLUSION

From the above results, its is clear that there is a definitive advantage in homogenizing finely chicken skin prior to starting fat recovery, both in terms of yields and of fat stability. Within the experimental conditions selected, the choice of the extraction temperature seems much less critical and the optimal processing temperature will depend on whether emphasis is put on yield (chose a higher temperature) or on stability (chose a lower temperature). Although our results suggest no microbiological problems associated with low extraction temperatures, additional experiments would be required to verify the safety of recovered fats, if extraction was to be performed at temperatures below 60°C.

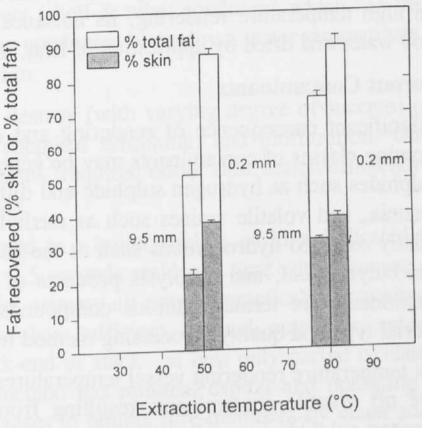

Figure 1: Effects of grind size and temperature on fat recovery

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Table 1: Influence of processing parameters on quality of fat recovered from chicken skin

		Conditions of extraction (temperature/degree of grinding)			
Fat quality		50°C/ 9.5 mm	50°C/ 0.2 mm	80°C/ 9.5 mm	80°C/ 0.2 mm
Insolubles %		0.017 ± 0.002 [1]	0.014 ± 0.005	0.012 ± 0.002	0.018 ± 0.007
Insaponifiables %		0.08 ± 0.02	0.17 ± 0.06	0.08 ± 0.02	0.21 ± 0.01
APC (CFU/g)		< 300	< 300	< 300	< 300
Residual water %		0.12 ± 0.01	0.16 ± 0.03	0.14 ± 0.04	0.13 ± 0.02
Colour of solid fat	L*	87.8 ± 0.1	84.9 ± 0.1	86.2 ± 0.3	84.8 ± 0.3
	a*	-1.1 ± 0.1	-1.2 ± 0.2	-1.3 ± 0.1	-1.3 ± 0.3
	b*	23.4 ± 0.2	25.0 ± 0.1	23.8 ± 0.2	24.2 ± 0.3
Peroxide index (PI)		0.78 ± 0.26	0.85 ± 0.04	0.98 ± 0.08	0.93 ± 0.11
Resistance to oxidation (h)[2]		70 ± 7	87 ± 10	70 ± 3	79 ± 5
PI after 2 months at 23°C		2.05 ± 0.54	1.19 ± 0.21	2.3 ± 0.13	1.79 ± 0.19
Free fatty acids (FFA, % oleic)		0.32 ± 0.01	0.33 ± 0.01	0.29 ± 0.01	0.33 ± 0.01
Lipolytic activity		nd[3]	nd	nd	nd
FFA after 2 months at 23°C		0.34 ± 0.04	0.37 ± 0.04	0.30 ± 0.01	0.34 ± 0.01

[1] Means ±SD (N=9); [2] Time to reach a PI of 10 at 70°C.
[3] Not detected; under the experimental conditions, lipolytic activity was detected in samples spiked with a control lipase (lipase 4 from *Candida*, Stern-Enzym GmbH).