EFFECT OF KIWIFRUIT AND FLAXSEED FLOURS ON THE TEXTURE OF SALAMI

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Abstract – Cold-pressed flaxseed cake and kiwifruit pulp flour are food by-products which are rich in dietary fibers which have known health benefits. Cold-pressed flaxseed cake and kiwifruit pulp flour were used at 10% addition level in either salami cooked at 100°C for 80 min or in fermented salami. Control salamis were also prepared. The texture of the treated and control samples were examined using texture profile analysis (TPA) and scanning electron microscopy. The addition of flours decreased (P< 0.05) the hardness, cohesiveness, gumminess chewiness and resilience. These parameters were in the following order; control > flaxseed flour > kiwifruit flour. The ultra-structure of flour containing samples appeared to be fragmented supporting the TPA results. The addition of flour protected the starter culture from the heat treatment in cooked samples. Cold-pressed flaxseed flour could be used at an addition level of less than 10%, but the optimum level of addition requires further research.

Key Words – Salami, dietary fibers, texture.

I. INTRODUCTION

Meat is an excellent source of high quality protein and several minerals (e.g. iron and zinc). A clearly deficient component in meat and many of its products is the lack of dietary fibers. Dietary fibers are important for gut health and the overall functioning of the digestive tract [1]. Several functions have been attributed to dietary fibers such as decreased transit time; relief and prevention of constipation; fast removal of toxic and carcinogenic compounds associated with harmful microflora; reduced blood cholesterol; improved metabolism of glucose and the absorption of minerals [1, 2].

It has been reported that intake of dietary fibers can reduce the occurrence of colorectal cancer [3, 4], a problem that has been casually linked to the consumption of red meat [5]. Therefore, the present study investigated the effects of cold-pressed flaxseed cake and kiwifruit pulp, which are rich sources of dietary fibers and abundant by-products in New Zealand, on the texture of cooked and fermented salami.

II. MATERIALS AND METHODS

Cold-pressed flaxseed cake (Functional Whole Foods, Geraldine, New Zealand) was detoxified as described previously from our lab [6], ground using a coffee grinder, and passed through a 1.18 mm sieve. Kiwifruit were chopped in half and juiced using a Breville juicer to separate the skin and the pulp. The pulp was centrifuged at 8500 ×g for 10 min at 4°C to separate the juice from the pulp. The obtained pulp was dried at 60°C and ground using the coffee grinder. Beef topsides (3 days post-mortem) were obtained from Alliance Group (Invercargill, NZ). Starter culture (BFL-F02 BactoFlavor®, containing *Pediococcus pentosaceus* and *Staphylococcus carnosus*) was a kind gift from Chr. Hansen Pty. Ltd, Australia. Three batches (about 10 kg each) of salami (control, flaxseed and kiwifruit) were prepared according to recipes in Table 1.

Table 1 Composition of materials used for salami preparation

Ingredients	Control	Flaxseed	Kiwifruit
Beef	81.9	72.9	72.9
Beef fat	9.1	8.1	8.1
Fibre	-	10.0	10.0
Salt	2.0	2.0	2.0
Nutmeg	0.01	0.01	0.01
Glucose	0.5	0.5	0.5
Garlic	1.2	1.2	1.2
Black pepper	0.6	0.6	0.6
Bay leaves	0.01	0.01	0.01
Chili	0.1	0.1	0.1
Paprika	0.4	0.4	0.4
Nitrite +nitrate	0.05	0.05	0.05
Fennel seeds	0.1	0.1	0.1
Sugar	2.0	2.0	2.0
Milk powder	2.0	2.0	2.0
total	100	100	100

The mixtures were then stuffed individually into casing using a stuffing machine (KM300-Chef,

Kenwood Electronic) to generate about 900-950 g salamis and the treatments were either cooked (100°C for 80 min) or fermented as described previously[7].

Texture Profile Analysis (TPA). The samples were subjected to texture profile analysis (TPA) as described by Barbut [8]. The calculated TPA parameters were; hardness, springiness, gumminess, adhesiveness, cohesiveness and chewiness. The samples (5 salamis/treatment) were used and 4 subsamples from each sample were tested using a Texture Analyzer (Stable Micro Systems TA.HD plus, Stable Micro Systems LTD). The instrument was set to compress the sample twice to 75% of original height at crosshead speed of 1.5 mm/s.

Scanning Electron Microscopy (SEM). A 1 cm^3 sample was removed from the center of each salami sample. The samples were then cut into smaller pieces (1mm × 1mm × 1mm) and were fixed for 1 hour in 2.5% glutaraldehyde in 0.2 M sodium cacodylate buffer (pH 7.2). The samples were then washed in buffer 3 times, in 0.2 M, 0.1 M and 0.05 M and washed in distilled water. After this, the samples were dehydrated for 5 minutes in 30%, 50%, 70%, 96%, and 100% ethanol, following drying in liquid CO_2 using a Balzers CPD 030 Critical Point Dryer. The samples were mounted on stubs with carbon paste, sputter coated with gold and palladium, and viewed in a Cambridge Instruments Stereoscan 360 Scanning Electron Microscope, at 15 kV.

Statistical Analysis. The mean of 2 measurements/ sample was averaged and used for the statistical analysis. Analysis of variance (ANOVA) was performed using the GLM protocol in Minitab (Version 16.0, Minitab Inc., Pennsylvania, USA) to determine the effects of treatment (cooked and fermented) and addition of dietary fiber (control, flaxseed and kiwifruit) and their interactions on the measured parameters. The differences between the least square means generated from the analysis were determined using the Tukey test at significance level of 0.05.

III. RESULTS AND DISCUSSION

The results of texture profile parameters (hardness, cohesiveness, adhesiveness, gumminess, springiness, chewiness and resilience) of the cooked and fermented salami are shown in Table 1. In general, the fermented samples had higher hardness than the cooked samples ($P < 0.05$). Fermented samples had lower springiness (except for kiwifruit flour containing samples) compared to cooked samples ($P < 0.05$). Generally, there were no significant differences in gumminess between the fermented and the cooked samples, except the flaxseed flour-containing samples where higher ($P < 0.05$) gumminess was found in fermented samples compared with cooked samples. There was no effect for the salami type (cooked vs fermented) on the cohesiveness values within the 3 treatments. Comparing the treatments of control, flaxseed and kiwifruit, the highest values of hardness, cohesiveness, gumminess and resilience were obtained in the control samples, followed by the flaxseed samples, and the kiwifruit samples had the lowest values ($P < 0.05$).

The fermented control salami had the highest hardness (143.83 ± 5.911 N), which was higher than the values reported by Herranz et al. [9] but lower than the values reported by Muguerza [10] and Bruna [11].

The values of gumminess, springiness and chewiness are in agreement with published reports [11, 12]. Kiwifruit containing salamis had the lowest hardness, cohesiveness, gumminess, chewiness and resilience values. This suggests a poor consistency of this salami and that the use of kiwifruit flour is not useful in salami.

The analysis of scanning electron microscope (SEM) of the salami samples is shown in Figure 1. The cooked samples (Figure 1A) containing flaxseed and kiwifruit flours had LAB bacterial growth more than the control samples indicating the cooking step was not successful in inhibiting the LAB starter culture and suggested some protection to the bacteria by the flours during the heat treatment. The flaxseed and kiwifruit samples had obvious gaps within the samples, whereas the control samples had much firmer texture (Figure 1). This was more obvious in fermented samples (Figure 1B) compared with cooked samples (Figure 1A). These results mirror the observed higher hardness and adhesiveness in control samples compared with flaxseed and kiwifruit flour–containing samples. The culture bacteria were more abundant in fermented control samples compared with kiwifruit flour-containing samples (Figure1B).

TPA parameter	Control		Flaxseed		Kiwifruit	
	cooked	fermented	cooked	fermented	cooked	fermented
Hardness (N)	115.65b	151.47a	52.40cd	74.42c	20.12e	46.70d
Gumminess (N)	70.17a	79.89a	19.15c	32.76b	3.49d	11.38cd
Cohesiveness	0.62a	0.53ab	0.36cd	0.44bc	0.16e	0.24de
Adhesiveness (J)	-0.08a	-1.87bc	-0.45ab	-1.54abc	-1.17abc	-2.70c
Springiness (m)	0.005a	0.003bc	0.004ab	0.003cd	0.002d	0.003cd
Chewiness (J)	0.32a	0.27a	0.08bc	0.10b	0.01c	0.03c
Resilience (mm)	0.19a	0.11b	0.08bc	0.09b	0.03c	0.04c

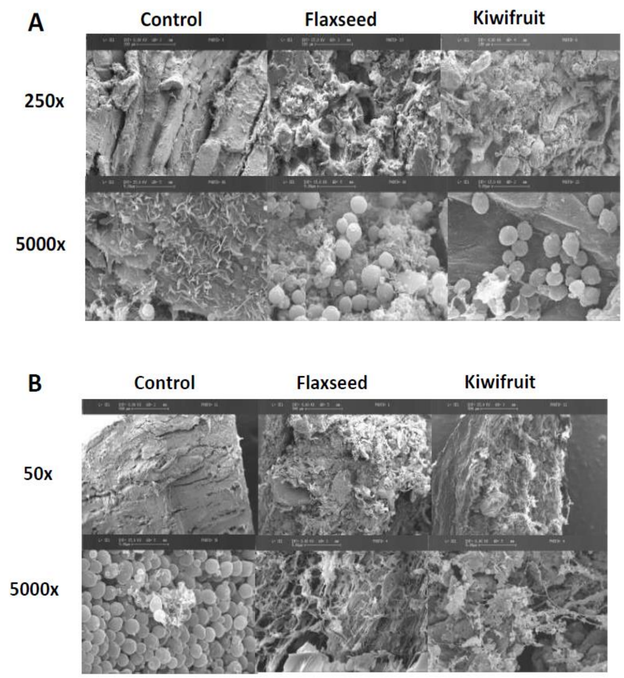

Figure 1. Electron microscope scans of cooked (A) and fermented (B) salami containing cold-pressed flaxseed flour, kiwifruit pulp flour or control.

IV. CONCLUSION

The use of cold-pressed flaxseed flour and kiwifruit pulp flour at 10% addition level decreased the firmness and cohesiveness of salami. Although kiwifruit pulp is a great source of dietary fibers, it is not suitable for salami making as it negatively affects the structure of salami. Cold-pressed flaxseed flour can be used and it might have better effects on salami texture at lower addition level.

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