ANTIOXIDANT EFFECT OF GRAPEFRUIT POWDER IN PORK PATTIES

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Abstract – The present study was undertaken to examine the utilisation of grapefruit powder peel [GPP] and bagasse [GPB] as a source of natural antioxidants to improve meat quality. GPP and GPB were characterized by their *in vitro* antioxidant activity (AOX), including total phenolic content (TPC), free radical scavenging activity (DPPH) and reducing power (RP). Pork patties (0%, 2% and 5% of GPP and GPB) were evaluated for pH, lipid oxidation (LOX) (thiobarbituric acid reactive substances [TBARS]), colour (a*), metmyoglobin formation (MetMb) and water holding capacity (WHC) during chilled storage (2 °C/9 days/under darkness). Results indicated that GPP>GPB in terms of antioxidant activity, although both are rich in TPC and exert good antiradical and RP properties ($P \leq 0.05$). Their incorporation in pork patties kept the pH values within the characteristic range of fresh pork meat (5.6) and significantly reduced LOX and MetMb (71.4% and 24.4% inhibition) as well as colour loss (23.6%) during chilled storage (GPP>GPB, mainly at the 2% addition level). Also, the values of WHC increased by 14.8% ($P<0.05$). The results indicate that grapefruit has great potential as a natural antioxidant ingredient to extend the shelf life of meat.

Key Words – Lipid oxidation, grapefruit, natural antioxidant, meat.

I. INTRODUCTION

Lipid oxidation (LOX) is one of the major causes of quality deterioration in raw and cooked meat and in meat products during refrigerated storage. Undesirable changes in colour, flavour, texture and nutritive value occur as LOX progresses. Synthetic antioxidants (SAx) have been widely used in meat and meat products to reduce LOX processes (ie butylated hydroxyanisole [BHA] and butylated hydroxytoluene [BHT]). However, increasing consumer concern over the safety of SAx and consumer preference for natural products have led to greater research on the use of natural antioxidants (NAx) derived from bee products and citrus fruits [1]. Grapefruit is characterised by its antioxidant properties, which are associated with its polyphenolic constituents and ability to capture free radicals [2]. Nevertheless, the effect of grapefruit powder as an oxidative stabiliser of raw pork patties was previously unknown. The objective of this work was to determine the effect of grapefruit powder on the quality of pork patties subjected to chilled storage.

II. MATERIALS AND METHODS

Antioxidant properties were assessed *in vitro* by determining the total phenolic content (TPC) according to Folin-Ciocalteu´s method in addition to antiradical (DPPH•, 1,1- diphenyl-2-picrylhydrazyl) and reducing power (RP) activities. The pork patties were composed of meat obtained from a local processor (24 h *postmortem*) and homogenised with 1.5% salt (NaCl, w/w) and at 10% fat (w/w, in final formulation). Polystyrene trays containing the patties were wrapped with polyvinyl chloride film (17,400 cm^3 O_2/m^2, 24 h at 23 °C). Five treatments of pork patties with two replicates were assessed: a) P (without additives), b) GPP (2% and 5%) and c) GPB (2% and 5%). The patties were subjected to refrigerated storage at 2 °C in the dark during 9 d, and 2 packs were opened for subsequent analysis of the following characteristics: pH, TBARS, MetMb, colour (a*), WHC and texture. Data were subjected to an ANOVA and a post-hoc test at $\alpha = 0.05$ (SPSS v. 21 statistical package) [3, 4].

III. RESULTS AND DISCUSSION

The total phenolic content of natural products is strongly associated with their biological properties [2,3]. In the present study, the TPC values in GPP and GPB samples were 83.6 ± 1.1 and 76.8 ± 1.5 mg of gallic acid equivalent (GAE)/mg of extract, respectively ($P<0.05$). Argentine and Brazilian norms indicate that the minimum TPC value required for a natural extract to exert an antioxidant effect is 50 mg GAE/mg [4]. To

determine the antioxidant properties of GPP and GBP samples, the antiradical DPPH• activity was evaluated (at 500 µg/mL). The DPPH assay measured the loss of deep violet colour of the DPPH• radical at 517 nm after reaction with an antioxidant compound. DPPH is a stable free radical that may accept an electron or hydrogen radical [3]. The results of this assay indicated that GPP and GBP exerted good antiradical DPPH• properties, with an inhibition percentage of 93.5% (P>0.05). The reducing power of a compound also supports its antioxidant activity [2]. The RP characteristics of GPP (0.3 ± 0.01) were significantly higher than those of GBP (0.2 ± 0.01) (P>0.05). These results indicate that grapefruit is an important source of natural antioxidants.

The incorporation of natural antioxidants rich in polyphenolic compounds to meat and meat products is a novel strategy for the development of meat products with a longer shelf life [4]. In this current investigation, the efficacy of GPP and GBP as ingredients for increasing meat quality during chilled storage was successfully evaluated (Table 1). The results showed no significant effects of GPP and GBP on the pH values (5.6, the characteristic value for fresh meat) of pork patties (P>0.05) [3]. Lipid and pigment protein oxidation is characterised by the formation of aldehydic products (MDA) and metmyoglobin (MetMb) [3,4]. On day 9, TBARS and MetMb formation were significantly lower in pork patties treated with grapefruit (mainly GPP and GPB at 2%) in comparison to the control group. Currently, meat colour is one of the most important organoleptic characteristics that can influence buyer acceptance and purchase decision. The a* value (redness), whose reduction can be associated with MetMb formation, was significantly maintained throughout storage time [3, 4, 5]. On day 9, pork patties treated with grapefruit showed high a* values (>14) in comparison to the control group (P<0.05). According to these results, GPP and GPB addition maintained the red colour of fresh pork patties during 9 days of storage. Also, the WHC of pork patties treated with grapefruit (2%) was not modified during storage time (WHC>2%), which could be associated with the fibre structure of grapefruit powder and the resulting hydrogen binding [2].

Table 1 Meat quality characteristics of pork patties

Analysis	Day	Control	GPP2%	GPP5%	GPB2%	GPB5%
pH	0	5.6 ± 0.1aA	5.6 ± 0.1aA	5.5 ± 0.1aA	5.6 ± 0.1aA	5.4 ± 0.1aA
	9	5.6 ± 0.1aA	5.6 ± 0.1aA	5.5 ± 0.2aA	5.5 ± 0.2aA	5.4 ± 0.2aA
TBARS (mg MDA/kg)	0	0.1 ± 0.01aA	0.1 ± 0.01aA	0.2 ± 0.01bA	0.1 ± 0.01aA	0.2 ± 0.01bA
	9	0.7 ± 0.01dB	0.2 ± 0.01aB	0.3 ± 0.01bB	0.3 ± 0.01bB	0.4 ± 0.01cB
MetMb (%)	0	1.2 ± 0.8abA	2.0 ± 0.2bA	2.5 ± 0.7bA	1.4 ± 0.2aA	1.3 ± 0.5aA
	9	63.6 ± 1.1cB	56.3 ± 1.7bB	48.1 ± 1.4aB	58.1 ± 1.6bB	55.2 ± 1.2bB
Colour a*	0	20.0 ± 1.4abB	22.4 ± 1.6bB	24.4 ± 0.7bB	17.5 ± 2.0aB	23.6 ± 1.4bB
	9	11.3 ± 0.9aA	14.8 ± 0.9bA	14.1 ± 1.0bA	12.1 ± 0.7aA	15.6 ± 0.8bA
WHC (%)	0	80.0 ± 1.2cB	75.7 ± 1.6bA	72.6 ± 1.7bA	71.3 ± 2.7bA	63.2 ± 1.8aB
	9	67.9 ± 1.9bA	76.7 ± 1.9cA	72.2 ± 1.5cA	74.6 ± 2.0cA	52.5 ± 0.6aA

MDA, malondialdehyde; MetMB, metmyoglobin; WHC, water holding capacity. GPP, grapefruit peel powder; GPB, grapefruit bagasse powder. Different superscripts (a–d) for the same sampling day and (A–B) storage time differ significantly (P<0.05).

IV. CONCLUSION

In this work, the current findings demonstrated that the use of grapefruit powder as an antioxidant in raw pork patties stored at 2 °C under darkness can effectively increase WHC and reduce LOX, MetMb formation and colour changes that may occur during chilled storage.

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