

CITRUS WASTES AS A SOURCE OF FUNCTIONAL INGREDIENTS IN MEAT PRODUCTS

By

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ABSTRACT

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Citrus fruit peel by-products can be promising source of functional compounds and dietary fiber. Lemon and orange peels (LP and OP) considered the primary citrus by-products and discarded as wastes. Re-using these wastes in a suitable form may be of considerable economic benefit to food processors.

The aim of this work was to study the potential use of orange and lemon peels as natural sources of functional ingredients e.g phenolic compounds and dietary fiber in meat products. Physico-chemical and functional properties as well as phenolic acids profiles of raw and dried peels were evaluated. Ethanolic and methanolic extracts of the fresh and dried peels (using microwave or air oven drying methods) were used to evaluate their phytochemical contents, antioxidant and antimicrobial activities. Proximate chemical composition, vitamin C, phenolic, flavonoids contents, also radical scavenging activities (DPPH), Trolox equivalent antiradical capacity (TEAC) and β -carotene assays, as well ferric reducing antioxidant power (FRAP) and Hydroxyl radical (OH^+) scavenging activity were determined.

In order to improve the functional value of meat product, application of these citrus peels at the levels 1 and 2% in the suggested ground beef meat patties formulae were carried out. Quality and shelf-life properties of beef patties as affected by adding citrus peels during refrigeration at 4°C for 15 days and freezing at -20°C for 30 days storage were studied.

Regarding to the results of physico-chemical analyses, it was noticed that fresh LP had higher %s of moisture, protein, ether extract, fiber and ash than OP. After drying, lemon peels still have had more crude protein, total fiber and ash contents except ether extract compared to

orange peel. The ash and fiber contents of lemon peels had significantly more %s compared to orange peels treated by microwave or air oven drying methods. Color investigation showed high lightness value for dried orange and lemon peels by air oven, high values of redness and yellowness color parameters were realized for microwave dried orange and lemon peels compared to control. Dried OPs by air oven had the highest water and oil holding capacities. However dried lemon peels by the same device were noticed to be higher in water holding capacity than control sample. Total dietary fiber content in fresh orange peel was of less % than lemon peels. Dried LPs by microwave and air oven was higher in total dietary fiber than that in orange peels. Fresh LPs contain more insoluble dietary fiber than OPs. After drying by the two mentioned methods, microwave dried lemon and orange peels still have more insoluble dietary fiber than that of air oven dried ones. Furthermore fresh and dried orange peel samples contain more soluble dietary fiber than the lemon peels.

The results of antioxidants analysis (phenols) and antioxidant activity conducted on successive extracts showed that the microwave drying did significantly affect these parameters in orange or lemon peels either methanolic or ethanolic extracts. An opposite pattern was noticed i.e. methanolic or ethanolic extracts of dried orange and lemon peels by air oven contained more flavonoids than microwave drying. The HPLC results revealed that naringin and hisperdin were the predominant phenolic acids in all tested samples with different concentrations.

Ethanolic extract of dried lemon peels by microwave inhibited *S. aureus*, *L. monocytogenes*, *B. subtilis*, *P. aeruginosa*, *S. typhi*, and *E. coli* bacteria compared to methanolic extract except *Aspergillus flavus* and *C. albicans* which showed no susceptibility to this extracts compared to ampicillin, antifungal agent amphotericin B and control. The methanolic extract of dried lemon peels with air oven showed low antimicrobial activity which inhibited only four bacteria, while the ethanolic extract was

more effective than that of methanolic extract in inhibition of six bacteria strains. Dried orange peel by microwave and extracted with ethanol inhibited *B. subtilis*, *E. coli*, *P. aeuroginosa*, *L. monocytogenes* and *C. albicans* compared to methanolic extract which inhibited *B. subtilis*, *E. coli*, *P. aeuroginosa*, and *C.albicans*.

Addition of 1 or 2% OP and LP to beef patties caused a reduction in moisture, thiobarbituric acid reactive substances, total volatile basic nitrogen, microbial count. Changes of pH value, shrinkage % and thawing values, somewhat increase in fat, ash, protein %, cooking yield, moisture retention, fat retention, water and oil holding capacity were noticed. In addition the levels of OP or LP (1 or 2%) affected the color, radical scavenging activity, texture and sensory properties relative to control.

Key words: Citrus by-products/waste, Lemon peels, Orange peels, Physico-Chemical compositions, Antioxidant properties, Phenolic compounds, Beef patties, Antimicrobial activity.

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CONTENTS

	Page
LIST OF TABLES.....	Vi
LIST OF FIGURES.....	IX
LIST OF ABBREVIATIONS.....	XI
1. INTRODUCTION.....	1
2. REVIEW OF LITERATURE.....	5
2.1. Food wastes (Food by-products).....	5
2.2. Citrus fruits and their by-products	7
2.2.1. Citrus	7
2.2.1.1. Functional ingredients of citrus	8
2.2.2. Citrus by-products	8
2.2.3. Citrus peels.....	10
2.2.3.1. Functional compounds of citrus peels.....	11
2.3. Bioactive compounds of citrus and citrus by-products.....	13
2.3.1. Phenolic compounds of citrus and their by- products.....	15
2.3.2. Flavonoids of citrus and their by-products	16
2.4. Antioxidant activity of citrus and their by-product extracts.....	19
2.5. Antimicrobial activity of citrus and their by-product extracts	21
2.6. Dietary Fiber of citrus and their by-products.....	23
2.7. Citrus by-products and their application in meat products.....	28
2.7.1. Meat and meat products.....	28
2.7.2. Meat & meat products and spoilage.....	28
2.7.3. Relationship between diet, food ingredients and health.....	31
2.7.4. Functional foods.....	32
2.7.5. Functional meat products.....	32
2.7.6. Some Application of using citrus by products in meat	
products.....	35
3. MATERIALS AND METHODS.....	38

3.1. MATERIALS.....	38
3.1.1. Citrus fruits	38
3.1.2. Chemicals	38
3.2. METHODS	38
3.2.1. Preparation of lemon and orange peels sample.....	38
3.2.2. Drying methods	38
3.2.2.1. Air oven.....	38
3.2.2.2. Microwave oven	39
3.2.3. Bioactive compounds extraction.....	39
3.2.3.1. Ethanol extraction	39
3.2.3.2. Methanol extraction	40
3.2.4. Analytical methods	40
3.2.4.1. Proximate chemical composition	40
3.2.4.2. Determination of vitamin C (total ascorbic acid).....	40
3.2.4.3. Phenolic analysis	40
3.2.4.3.1. Determination of total phenolic content	40
3.2.4.3.2. Determination of total flavonoids content.....	41
3.2.4.3.3. Analysis of extracts by HPLC	41
3.2.4.3.4. Antioxidant activity assays	42
3.2.4.3.4.1. Determination of radical scavenging activity....	42
3.2.4.3.4.2. Determination of ABTS radical scavenging activity.....	42
3.2.4.3.4.3. β -carotene bleaching test	43
3.2.4.3.4.4. Ferric reducing power (FRAP) assay	44
3.2.4.3.4.5. Hydroxyl radical (OH) scavenging activity.....	44
3.2.4.4. Determination of Dietary fiber	44
3.2.4.5. Physical and functional properties	47
3.2.4.5.1. Color measurement	47
3.2.4.5.2. pH determination	47
3.2.4.5.3. Water and oil holding capacities	47
3.2.5. Antimicrobial activity assay.....	47
3.2.5.1. Media	47
3.2.5.2. Microorganism	48

3.2.5.3. Antimicrobial assay (disk diffusion assay).....	48
3.2.5.4. Determination of the minimum inhibitory concentration.....	49
3.2.6. Application of orange or lemon peels powder in beef patties.....	50
3.2.6.1. Material of beef patties.....	50
3.2.6.2. Preparation of beef patties	50
3.2.6.3. Thiobarbituric acid reactive substances (TBARS).....	51
3.2.6.4. Total volatile basic nitrogen (TVBN).....	52
3.2.6.5. Microbiological examination	52
3.2.6.5.1 Preparation of medium used for T.P.C	52
3.2.6.5.2. Sample preparation and microbial examination.....	53
3.2.6.5.3. Total plate count (T.P.C).....	53
3.2.6.6. Physical and Functional properties for beef patties.....	53
3.2.6.6.1. Texture profile analysis.....	53
3.2.6.6.2. Cooking characteristics.....	53
3.2.6.6.3. Thaw loss	54
3.2.6.7. Sensory evaluation of beef patties	54
3.2.7. Statistical analysis.....	54
4. RESULTS and DISCUSSION.....	55
4.1. Chemical properties of orange and lemon peels.....	55
4.1.1. Proximate chemical composition.....	55
4.1.2. Ascorbic acid content.....	56
4.1.3. Phenolic analysis	57
4.1.3.1. Total phenolic content	57
4.1.3.2. Total flavonoids content	60
4.1.3.3. Phenolic acids profiles of citrus by-products	61
4.1.3.4. Antioxidant properties	67
4.1.3.4.1. Radical scavenging activities (DPPH*).....	68
4.1.3.4.2. Determination of ABTS radical scavenging activity	70
4.1.3.4.3. β -carotene bleaching Assay	72
4.1.3.4.4. Ferric ions reducing antioxidant power assay.....	74

4.1.3.4.5. Hydroxyl radical (OH) scavenging activity	76
4.1.4. Dietary fiber content	78
4.1.5. Physical and functional properties	79
4.1.5.1. Color	79
4.1.5.2. Water and oil holding capacities and pH changes.....	82
4.2. Microbiology of citrus peels	83
4.2.1. Antimicrobial activity by agar disc diffusion method.....	83
4.2.2. Minimum inhibitory concentration (MIC).....	91
4.3. Application of citrus peels in beef patties.....	92
4.3.1. Quality and shelf-life of beef patties as affected by adding powder of orange and lemon peels during refrigerated storage	94
4.3.1.1. Proximate chemical composition	94
4.3.1.2. Thiobarbituric acid reactive substances (TBARS).....	97
4.3.1.3. Total volatile basic nitrogen (TVBN).....	99
4.3.1.4. Radical scavenging activity (DPPH)	101
4.3.1.5. Microbial evaluation (Microbial count).....	102
4.3.1.6. Functional and physical properties.....	104
4.3.1.6.1. Water and oil holding capacities.....	104
4.3.1.6.2. Determination of pH value	106
4.3.1.6.3. Instrumental color measurements of beef patties...	108
4.3.1.6.4. Texture profile analysis	110
4.3.1.6.5. Cooking characteristics	113
4.3.1.7. Sensory evaluation.....	116
4.3.2. Quality and shelf-life of beef patties as affected by adding of powder of orange and lemon peels during frozen storage.....	118
4.3.2.1. Proximate chemical composition	118
4.3.2.2. Thiobarbituric acid reactive substances (TBARS).....	119
4.3.2.3. Total volatile basic nitrogen (TVBN).....	122
4.3.2.4. Microbial evaluation (Microbial count).....	123
4.3.2.5. Functional and physical properties	124
4.3.2.5.1. Water and oil holding capacity values	124
4.3.2.5.2. Thawing loss values	125

4.3.2.5.3. Texture profile analysis	127
5. SUMMARY AND CONCLUSION.....	130
6. REFERENCES.....	144
7. ARABIC SUMMARY.....	

LIST OF TABLES

No		Page
1	Proximate chemical composition of orange and lemon peels as affected by air oven and microwave drying (db).....	55
2	Effect of air oven and microwave drying methods on ascorbic acid content (mg/100g sample db) of orange and lemon peels	57
3	Total phenolics content (mg /100g sample equ. Gallic acid) in methanolic or ethanolic extracts of orange and lemon peels	59
4	Total flavonoids content (mg quercetin /100g sample) in fresh and dried orange and lemon peels extracted by methanol or ethanol (db).....	60
5	Phenolic acids profile of orange and lemon peel extracts ($\mu\text{g}/100\text{g}$ sample) detected using HPLC.....	63
6	Radical scavenging activities % of dried orange and lemon peels extracted by methanol or ethanol	69
7	ABTS antiradical capacity (mM Trolox equivalent) of dried orange and lemon peels extracted by methanol or ethanol.....	71
8	Effect of drying methods on β -carotene (IC_{50} mg/ml) of orange and lemon peels extracted by methanol and ethanol...	73
9	Ferric reducing power activities μM Trolox eq/100g db of orange and lemon peels extracted by methanol and ethanol...	75
10	Hydroxyl radical scavenging activities (OH) of orange and lemon peels extracted by methanol and ethanol	77
11	Effect of some different drying methods on dietary fiber of orange and lemon peels.....	78
12	Color attributes of fresh and powder orange and lemon peels.	81
13	Water and oil holding capacities (as g of water or oil held/g sample) and pH changes of orange and lemon peels as affected by air oven and microwave drying methods.....	83
14	Antimicrobial activity of lemon extracts against bacteria and	

VII

	yeast measured in (mm).....	86
15	Antimicrobial activity of orange extracts against bacteria and yeast measured in (mm).....	87
16	Minimum inhibitory concentration ($\mu\text{l/ ml}$) of ethanolic dried orange and lemon peels by microwave.....	91
17	Proximate chemical composition of beef patties formulae during refrigerated storage at $4\pm 1^{\circ}\text{C}$ for 15 days (W/W) *	95
18	TBARS values changes of beef patties sample during refrigerated storage at $4\pm 1^{\circ}\text{C}$ for 15 days	98
19	Total volatile basic nitrogen (mg N/100g sample) changes of beef patties during refrigerated storage at $4\pm 1^{\circ}\text{C}$ for 15 days..	100
20	Changes radical scavenging activity% values of beef patties sample during refrigerated storage at $4\pm 1^{\circ}\text{C}$ for 15 days.....	101
21	Total plate count changes of beef patties sample during refrigerated storage at $4\pm 1^{\circ}\text{C}$ for 15 days.....	103
22	Water and oil holding capacity values changes of beef patties sample during refrigerated storage at $4\pm 1^{\circ}\text{C}$ for 15 days.....	105
23	pH changes of beef patties during refrigerated storage at $4\pm 1^{\circ}\text{C}$ for 15 days.....	107
24	Instrumental color values of beef patties as affected by addition of citrus peel powder during refrigerated storage at $4\pm 1^{\circ}\text{C}$ for 15 days.....	109
25	Effect of incorporation of powder orange and lemon peels on the textural characteristics of the prepared beef patties during refrigerated storage at $4\pm 1^{\circ}\text{C}$ for 15 day.....	110
26	Cooking characteristic means of the beef patties containing powder of orange and lemon peels during refrigerated storage at $4\pm 1^{\circ}\text{C}$	115
27	Sensory evaluation of the beef patties containing powder of orange and lemon peels during refrigerated storage at $4\pm 1^{\circ}\text{C}$.	117
28	Proximate chemical composition (%) of beef patties formulated with adding 1 or 2% powdered orange and lemon	