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Effect of some Spices and their Volatile Oils on the Quality Attributes of Frozen and Semi-Fried Fish Fillets

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6. SUMMARY

This study was carried out to prepare uncooked and semi-fried coated tilapia fillets by using two spices mixtures i.e., garlic and cumin mixture (GC), garlic and parsley mixture (GP) and their volatile oils mixtures. Chemical composition, chemical, physical, microbiological and sensory properties of coated tilapia fillets during frozen storage at – 18ºC for 3 months were evaluated.

The obtained results can be summarized as follows:

6.1. Proximate composition of fresh tilapia fillets:

Fresh tilapia fillets contained 77.94% moisture, 18.62% crude protein, 1.86% crude fat, 1.39% total ash and 0.19% carbohydrates content (on a wet weight basis). Meanwhile, these values reached 84.41% crude protein, 8.43% crude fat, 6.30% total ash and 0.86% carbohydrates content (On dry weight basis).

6.2. Volatile oils used in preparation of coated tilapia fillets

6.2.1. Chemical components of volatile oils:

Eleven, thirteen and fourteen components were isolated and identified from garlic, parsley and cumin volatile oils by GLC which represented 96.47, 97.79 and 95.41%, respectively. Diallyl disulfide, diallyl trisulfide and allyl methyl trisulfide were the most abundant chemical compounds in garlic volatile oil which represented 70.38% of the total identified chemical compounds. Moreover, Myristicin (22.08%) was the major component of parsley volatile oil followed by α-pinene (13.25%) and γ-Terpinene (12.05%). On the other hand, cumin aldehyde, γ-Terpinene, β-pinene and cuminic alcohol were the most predominant chemical compounds in cumin volatile oil which represented 81.54%.

6.2.2. Antioxidant activity of volatile oils:

There were significant differences between antioxidant activity of all volatile oils and their mixtures. The highest antioxidant activity (93.63 %) was recorded for garlic and cumin volatile oil mixture (GC) followed by garlic and parsley volatile oils mixture GP (88.90%). On the other hand, the lowest antioxidant activity (79.56%) was observed for parsley volatile oil. Finally volatile oils can be sorted according to their antioxidant activity in the following descending order: garlic and cumin volatile oils mixture (GC) > garlic and parsley volatile oils mixture (GP) > garlic > cumin > parsley.

5.2.3. Antimicrobial activity of volatile oils

The antimicrobial activity of volatile oils and their mixtures was affected by the types of volatile oils and microbial strains. The highest antimicrobial activity was recorded for mixture of garlic and cumin volatile oils (GC), with inhibition zones ranged from 35.0 to 53.0 mm followed by garlic and parsley volatile oils mixture (GP) with inhibition zones ranged from 34.0 to 51.0 mm when compared with other volatile oils. Also, garlic volatile oil was more effective on all tested microbial strains than cumin and parsley volatile oil.

The antibacterial effects of different volatile oils and their mixtures were more pronounced on gram positive bacteria than gram negative bacteria. Also, all mold strains were more sensitive to all tested volatile oils and their mixtures when compared with bacteria and yeast strains. Finally, volatile oils and their mixtures could be arranged in descending order according to their antimicrobial potency as follows: mixture of garlic and cumin (GC) > mixture of garlic and parsley (GC) > garlic > cumin > parsley volatile oil.

Also, microbial strains types could be arranged descendingly according to their resistance to volatile oils as follows: Gram negative bacteria > Gram positive bacteria > yeasts > molds.

Each garlic and cumin volatile oils mixture and garlic and parsley volatile oils mixture were selected based on their antioxidant and antimicrobial potential property in preparation of coated tilapia fillets.

5.3. Selection of the best volatile oils mixtures percentage to use in coating tilapia fillets:

Organoleptic evaluation indicated that, use of 500 ppm of both garlic and cumin volatile oils mixture (GC) and garlic and parsley volatile oils mixture (GP) in preparation of edible coatings for coating tilapia fillets improved the sensory properties when compared with other percentages (250 and 750 ppm). Therefore it could be recommended as the best percentage in preparation of tilapia fillets.

5.4. Sunflower seed oil used in semi-frying of coated tilapia:

5.4.1 Physical and chemical properties of sunflower seed oil.

Results indicated that acid value, peroxide value, iodine number, refractive index, specific gravity and conjugated diene (Uv absorbance at 232 nm) of sunflower seed oil were 0.132 mg KOH/ g oil, 1.89 meq O_2/kg oil, 132.16, 1.4170, 0.9064 and 1.068, respectively.

5.4.2. Fatty acids composition of sunflower seed oil:

Results indicated that sunflower oil consisted of 11 fatty acids, six of them were unsaturated represented (88.41% of total fatty acids) and the rest were saturated which represented 10.55% of total fatty acids. Linoleic acid was the major unsaturated fatty acid in sunflower seed oil (57.83%) followed by oleic acid (30.16%). On the other hand, palmitic acid was the major saturated fatty acid (6.84%) followed by stearic acid (3.34%).

5.5. Coated tilapia fillets:

5.5.1. Proximate composition of coated tilapia fillets

Proximate composition of coated tilapia fillets were not affected ($p > 0.05$) by the type and form of additives but significantly affected by cooking process and frozen storage period at – 18°C. There were no significant differences ($p >0.05$) in proximate composition between coated tilapia fillets without additives (control sample) and that coated with different types of additives (GP and GC) and also between coated tilapia fillets prepared with volatile oils mixtures and coated tilapia fillets prepared with spices mixtures.

Semi-fried coated tilapia fillets had significantly lower ($p \leq 0.05$) moisture content (63.30%) but significantly higher crude protein (18.45%), crude fat (5.97%), total ash (1.94%) and carbohydrates content (10.53%) than uncooked coated tilapia fillets.

The moisture and protein contents of coated tilapia fillets were significantly ($p \leq 0.05$) decreased from 66.85 and 18.04% at zero time to 65.65 and 17.50% after 3 months of frozen storage, respectively. On the other hand, crude fat, total ash and carbohydrates contents of coated tilapia fillets were significantly ($p \leq 0.05$) increased from 3.67, 1.52 and 9.93 % at zero time to 4.31, 2.15 and 10.39%, respectively after 3 months of frozen storage.

5.5.2. Fatty acids profile of coated tilapia fillets:

Eighteen fatty acids were identified in all coated tilapia fillets whether uncooked or semi fried samples. Six of these fatty acids were saturated ranged from 44.82 to 45.15 and 19.92 to 21.19% of total fatty acids for uncooked and semi fried samples, respectively; four fatty acids were mono unsaturated which ranged from 28.33 to 28.49 and 27.47 to 28.46% of total fatty acids for uncooked and semi fried samples, respectively. The rest fatty acids were polyunsaturated which ranged from 26.31 to 26.58 and 51.29 to 52.38 % of total fatty acids for uncooked and semi fried samples, respectively.

Palmitic acid was the major saturated fatty acid in all uncooked tilapia fillets samples followed by stearic acid and myristic acid, meanwhile oleic acid (C18:1ω-9) was the major monounsaturated fatty acid in all uncooked tilapia fillets followed by palmitoleic acid. On the other hand, DHA (C22:6 ω -3) was the major polyunsaturated fatty acid in all uncooked tilapia fillets followed by linoleic acid (C18:2 ω-6).

Fatty acids composition of coated tilapia fillets was affected by semi-frying process. All saturated fatty acids were decreased by semi-frying process. Also, semi frying process of coated tilapia fillets led to decrease most of monounsaturated and polyunsaturated fatty acids but increase oleic acid (C18:1ω-9) and linolenic acid (C18:2ω -6). Also, semi frying process decreased total omega-3 fatty acids and increased total omega-6 fatty acids.

5.5.3. Chemical quality attributes of coated tilapia

Chemical quality attributes (TBV, TMA and TBA) of coated tilapia fillets were significantly affected ($p \leq 0.05$) by the type and form of additives, cooking process and frozen storage at -18ºC up to 3 months. Coated tilapia fillets without additives had significantly higher ($p \leq 0.05$) TVN, TMA and TBA than tilapia fillets coated with different types of additives (GP and GC). Also, coated tilapia fillets prepared with garlic and cumin mixture (GC) had significantly lower ($p \leq 0.05$)

TVN, TMA and slightly lower ($p>0.05$) TBA than coated tilapia fillets prepared with coating contained garlic and parsley mixture (GP).

Also, addition of spices volatile oils mixtures was more effective than spices powder mixtures on reduction of TVN, TMA and TBA values.

Semi-fried coated tilapia fillets had significantly lower ($p \leq 0.05$) TVN (10.85 mg/100g) and TMA (4.97 mg/100g) but significantly higher TBA value (0.778 mg malonaldhyde /kg) than uncooked coated tilapia fillets.

The T.V.N, TMA and TBA values of coated tilapia fillets were significantly ($p \leq 0.05$) increased from 8.28 mg/100g, 2.83 mg /100g and 0.458 mg malonaldhyde/kg at zero time to 15.19 mg/100g, 7.60 mg/100g and 0.983 mg malonaldhyde/kg at the end of frozen storage period, respectively.

5.5.4. Physical properties of coated tilapia fillets

Results indicated that there were no significant differences ($p >0.05$) in plasticity between coated tilapia fillets without additives (1.94cm^2/g) and coated tilapia fillets with both GP (1.97 cm^2/g) and GC (1.96 cm^2/g). Control sample had significantly higher ($p\leq 0.05$) pH value

(6.40), water holding capacity value (high value means lowest or worst water holding capacity 2.87cm^2/g) and cooking loss (21.95%) than coated tilapia fillets with different additives (GC and GP).

All physical properties of coated tilapia fillets were not affected (p> 0.05) by the form of additives (powder or volatile oils), but significantly affected (p≤0.05) by cooking process. Semi fired coated tilapia fillets had significantly higher (p ≤ 0.05) pH value (6.124) but significantly lower (p ≤ 0.05) water holding capacity value (best WHC, 2.32 cm^2/g), plasticity (2.32cm^2/g) and cooking loss (22.39%) than uncooked coated tilapia fillets.

Physical properties of coated tilapia fillets were also significantly affected (p≤ 0.05) by frozen storage periods at -18±1°C. The pH value and cooking loss of coated tilapia fillets were significantly (p≤ 0.05) increased by increasing frozen storage period. On the other hand, the water holding capacity (i.e., separated free water increased) and plasticity were significantly decreased with advancement of storage

5.5.5. Microbiological evaluation of coated tilapia fillets:

The uncooked tilapia fillets coated without additives (control sample) had higher total bacterial count, coliform, *staphylococcus* *aureus*, lipolytic and proteolytic bacteria counts than uncooked tilapia fillets coated with coatings contained different additives at zero time.

Semi-frying process led to decrease total bacterial counts from (3.56×10^4– 9.97×10^4 cfu/g) for uncooked samples to (4.52×10^2 – 8.17×10^2 cfu/g) immediately after semi-frying process. On the other hand, coliform, *staphylococcus aureus*, lipolytic and proteolytic bacteria growth were inhibited by semi frying process.

Total bacterial count, coliform, *staphylococcus aureus*, lipolytic and proteolytic bacteria counts of uncooked fillets were affected by the type and form of additives. At any time of frozen storage, tilapia fillets coated with coatings contained garlic and cumin mixture (GC) in the form of powder or volatile oils had lower counts of abovementioned bacteria than tilapia fillets coated with coatings contained garlic and parsley mixture (GP). Also, tilapia fillets coated with coatings contained volatile oils mixtures (GC or GP) had lower counts of abovementioned bacteria than tilapia fillets coated with coatings contained spices mixtures powder.

Total bacterial counts of uncooked and semi-fried tilapia fillets were affected by frozen storage at -18±1ºC. Total bacterial counts of uncooked and semi-fried coated tilapia fillets was slightly decreased by increasing the storage period up to the first month of frozen storage and then increased slightly until the end of frozen storage. The same trend was recorded for *staphylococcus aureus*, lipolytic and proteolytic bacteria counts in uncooked tilapia fillets during frozen storage. On the other hand, coliform bacteria count of all uncooked tilapia fillets samples gradually decreased by increasing frozen storage period up to 3 months.

All uncooked and semi-fried coated tilapia fillets were completely free from *Salmonella spp*, yeasts and molds at zero time and during frozen storage at -18±1ºC up to 3 months.

5.5.6. Sensory properties of coated tilapia fillets

There were significant differences ($p \leq 0.05$) in all sensory properties scores between coated tilapia fillets without additives (control sample) and tilapia fillets coated with different types of additives (GP and GC) except texture score showed non-significant differences between them. Also, non- significant differences ($p \leq 0.05$) in all sensory properties scores were observed between coated tilapia fillets prepared with GP and GC. Control sample had significantly lower scores of taste

(7.53), odor (6.64), color (6.75), texture (7.15) and overall acceptability (7.02) than that coated with different additives (GC and GP).

Sensory properties of coated tilapia fillets were significantly affected by the form of additives. Coated tilapia fillets prepared with volatile oils mixtures had significantly higher ($p \leq 0.05$) scores of taste, odor, color, texture and overall than coated tilapia fillets prepared with spices mixtures powder.

Also, sensory properties of coated tilapia fillets were significantly affected ($p \leq 0.05$) by cooking process. Semi-fried coated tilapia fillets had significantly lower ($p < 0.05$) scores of taste (7.52), odor (7.19), color (6.72) and overall acceptability (7.26) but significantly higher texture (7.63) than uncooked coated tilapia fillets.

Moreover, sensory properties of coated tilapia fillets were also significantly affected ($p \leq 0.05$) by frozen storage periods at -18±1°C. All sensory properties of coated tilapia fillets were significantly ($p \leq 0.05$) decreased by increasing storage period up to 3 months.