PROTECTIVE EFFECT OF PARSLEY (*Petroselinum crispumm* Mill.) AGAINST LIPID OXIDATION IN OMELETS PREPARED BY DIFFERENT COOKING METHODS

ABSTRACT

This study investigated the effectiveness of parsley (*Petroselinum crispumm* Mill.) against lipid oxidation during the thermal preparation of omelets by pan frying, microwaving, and air frying. The lipid oxidation was measured by determining the substances reactive to thiobarbituric acid (TBARS) value, which increased after cooking indicating the formation of malonaldehyde (MDA). Raw omelets presented 1.11 ± 0.09 mg MDA/kg, while levels ranging from 1.62 ± 0.03 (microwaving) to 1.91 ± 0.02 mg MDA/kg (air frying) were found in cooked omelets. Air frying most induced MDA formation, which can be linked to the most extreme conditions applied in this method. However, lower TBARS values were determined in samples containing parsley, regardless of the cooking method applied, revealing its antioxidant effect. Moreover, differences due to the different concentrations of herb employed were not observed for most samples ($p > 0.05$). Thus, these findings highlight the use of parsley, which is a traditional culinary practice, as a suitable strategy to limit lipid oxidation during omelet preparation.

INTRODUCTION

High temperatures applied during cooking may affect food constituents in distinct ways. In foods, lipids are mainly degraded by oxidative processes, which involve unsaturated compounds and pro-oxidant elements such as heat, oxygen, and light (1,2). Thus, the lipid fraction of eggs, which must be cooked prior consumption and contain polyunsaturated fatty acids (PUFAs), is highly prone to oxidation during thermal preparations (3).

Eggs are popular sources of nutrients that have emerged as basic components of a healthy diet since their constituents show remarkable biological activities (4,5). They are economically affordable and present interesting characteristics such as practicality and versatility. Moreover, eggs have great potential for daily meals and are recognized as basic ingredients of numerous culinary recipes (5), being widely used by the food industry in processed food products (6).

Due to the role of eggs in human diet, it is worth considering the impact of cooking on their lipids. Lipid oxidation is the main cause of loss of quality in food, compromising its sensorial and nutritional aspects (2). Studies have reported losses of important fatty acids due to oxidation (3,7,8). In addition, the ingestion of oxidized lipids has been associated with the development of chronic diseases (9,10).

It is evident the importance of retarding or minimizing lipid oxidative reactions in food, which can be mainly achieved by using antioxidants (2,3). Eggs contain natural antioxidants; however, these compounds may be degraded during heating (11). Thus, the addition of extra sources of antioxidants should be considered during eggs' cooking.

Herbs have been widely applied to enhance the color, flavor, and aroma of food dishes. However, they have drawn researchers' attention due to their antioxidant properties (12). Among the popular herbs widely applied in culinary, parsley

(*Petroselinum crispum* Mill.) has been extensively reported due to their large spectrum of antioxidant components, which include phenolic acids, flavonoids, carotenoids, and others (3,7,13). Thus, besides acting as a flavor agent, parsley may also show numerous bioactivities since it is a rich source of phytochemicals, and a remarkable potential to act as a natural preservative in food.

OBJECTIVE

This study aimed to evaluate the protective effect of parsley (*Petroselinum crispumm* Mill.) against lipid oxidation during omelet preparation by different cooking methods (pan frying, microwaving, and air frying).

RESULTS AND DISCUSSION

Fresh organic parsley (*Petroselinum crispum* Mill) was donated by producers from Seropédica, Rio de Janeiro. Fresh eggs, with an average weight of 60–62 g, were purchased from a local supermarket also located in Seropédica. The eggs used were registered according to the Brazilian legislation, being all from the same lot and classified as “Type 1, extra”.

Firstly, the eggs were evaluated before cooking (raw samples). For this, the eggshells were manually broken and removed. Then, egg yolk and white were mixed using a domestic mixer to obtain a homogenous sample. The same procedures were carried out for samples intended to the thermal treatment.

Samples were prepared with mixed egg yolk and white and fresh herb as follows: samples not added with the herb (control) and samples added with parsley (0.25, 0.5, and 0.75%). Informal tests of sensory analysis were performed with the laboratory team to determine the percentage of addition, which was calculated according to the weight of each omelet (150 ± 0.5 g, 3 eggs).

Different temperature/time binomials can be used during cooking, thus, there are no standard procedures for the thermal preparation of omelets. At the present study, the parameters applied were established as described by Oliveira et al. (3), who focused on mimicking domestic preparations. Moreover, following authorities’ recommendations to ensure food safety, the minimum internal temperature of 70 °C (14) was defined, being monitored with a digital thermometer.

Pan frying was performed using a domestic stove (Esmaltec, Brazil) and a Teflon frying pan for 4 min. The sample was turned over at 1-min intervals, totaling 2 min of cooking for each omelet side. A microwave oven (CCE, Brazil) was used to cook the omelets for 3 min (600 W). An air fryer device model RI9225/50 (Philips Walita, São Paulo, Brazil) was used. The equipment temperature was set at 220 °C. Then, the air fryer form containing the sample was placed in the chamber and the sample was heated for 10 min.

Lipid oxidation was measured by determining the TBARS values as described by Vyncke (15). The readings were performed at 532 nm and results were expressed as mg malonaldehyde (MDA)/kg sample. The TBARS method is widely applied to investigate the occurrence of oxidative processes in food by quantifying the substances reactive to thiobarbituric acid. It determines the content of malonaldehyde, which is a product of the decomposition of hydroperoxides, being a secondary product of oxidation (16).

The TBARS values determined for raw and cooked omelet samples are shown in Table 1. Raw omelets presented a TBARS value of 1.11 ± 0.09 mg MDA/kg sample. Higher values for TBARS were determined after heating ($p < 0.05$), which reflects the occurrence of oxidative processes and, consequent, formation of secondary products of lipid oxidation, such as malonaldehyde. After heating, the control samples showed the following contents of MDA: 1.62 ± 0.03 mg MDA/kg (microwaving), 1.65 ± 0.02 mg MDA/kg (pan frying), and 1.91 ± 0.02 mg MDA/kg (air frying). These results demonstrate that air frying caused the highest impact on malonaldehyde formation, while no significant differences were observed among the values determined for microwaving and pan frying ($p > 0.05$).

Table 1: TBARS value (mg MDA/kg, dry basis) of raw and cooked omelets (control and with parsley at 0.25, 0.5, and 0.75 %).

			Air frying		
	Raw	**Control**	**0.25% parsley**	**0.5% parsley**	**0.75% parsley**
TBARS value (mg MDA/kg)	1.11 ± 0.09	1.91 ± 0.02A;a;*	1.65 ± 0.05B;a;α;*	1.57 ± 0.04BC;a;α;*	1.51 ± 0.04C;a; α;*
			Pan frying		
	Raw	**Control**	**0.25% parsley**	**0.5% parsley**	**0.75% parsley**
TBARS value (mg MDA/kg)	1.11 ± 0.09	1.65 ± 0.02A;b;*	1.55 ± 0.27A;a;*	1.48 ± 0.05A;a;*	1.27 ± 0.10A;b;β;*
			Microwaving		
	Raw	**Control**	**0.25% parsley**	**0.5% parsley**	**0.75% parsley**
TBARS value (mg MDA/kg)	1.11 ± 0.09	1.62 ± 0.03A;b;*	1.61 ± 0.02AB;a;*	1.57 ± 0.04 AB;a;*	1.52 ± 0.04B;a;δ;*

Values represent means ± standard deviation in triplicates. Different capital letters indicate significant differences among the percentages of parsley addition for each cooking method by the Tukey test. Different lowercase letters indicate significant differences among the cooking methods considering the same percentage of parsley addition by the Tukey test. Air frying - "α" indicates significant differences compared to "Control" by the Dunnett test. Pan frying - "β" indicates significant differences compared to "Control" by the Dunnett test. Microwaving - "δ" indicates significant differences compared to "Control" by the Dunnett test. "*" indicates significant differences of any samples compared to "Raw".

Domestic cooking techniques, such as pan frying (11,17), boiling (11,17), and microwaving (18), have shown to induce oxidative reactions resulting in increased levels of MDA in eggs. TBARS value of eggs increased from 0.39 to 1.03 mg MDA/kg after pan frying (205 °C/ 6 min) in a study performed by Nimalaratne et al. (11). As reported by Ren et al. (17), pan-fried eggs generated the highest content of MDA (2.02 mg MDA/kg) compared to boiled (1.44 mg MDA/kg) and raw eggs (0.56 mg MDA/kg), which was attributed to the higher temperature applied during pan frying (177 °C/ 80 s) compared to boiling (100 °C/10 min).

Similar findings can be highlighted in the present study, where air frying, which was conducted using the most extreme cooking conditions (220 °C/ 10 min) and achieved the highest internal temperature in samples (138 °C), showed the highest formation of MDA. Pan-fried and microwaved omelets presented lower internal temperatures (84 and 95 °C, respectively), which reflected in the lower levels of MDA determined in these samples.

Although the studies (11,17) were carried out under different conditions and even with different cooking methods, they support the principle that exposure to high temperatures accelerates oxidative processes in food by reducing the activation energy required for the hydrogen abstraction and formation of free radicals (1). During oxidation, free radicals react with triplet oxygen and generate reactive peroxyl radicals that interact with surrounding molecules to form hydroperoxides, which may degrade and result in the formation of MDA (19).

Lower results of TBARS were found in samples added with parsley ($p < 0.05$). In general, the higher the concentration of herb added to samples the greater the protective effect. However, results obtained when different levels of parsley were added, regarding the same cooking method, were not statistically different ($p > 0.05$), except for air-fried samples (comparing the results from 0.25 and 0.75%). Therefore, the results from samples added with 0.75% parsley, which was the highest levels applied, were considered for discussion.

After air frying, samples added with 0.75% parsley showed a MDA content of 1.51 ± 0.04 MDA/kg, which was lower than the one assessed in control samples (1.91 ± 0.02 mg MDA/kg) ($p < 0.05$). Similar trend was observed for pan-fried and microwaved samples, where the levels of MDA were 1.27 ± 0.10 and 1.52 ± 0.04 mg MDA/kg, respectively.

The protective effect of parsley against the formation of MDA highlights its antioxidant potential, which is mainly linked to the presence of phenolic compounds such as flavonoids and phenolic acids (3,7,13). These compounds inactivate free radicals that initiate the oxidation process by both hydrogen atom transfer and electron transfer mechanisms. Moreover, they may also protect lipids from oxidants by acting as oxygen and metal ion scavenger, for example (12).

CONCLUSION

Eggs are high-quality nutrient resources; however, the different cooking procedures applied during their thermal preparation may induce the oxidation of their lipid fraction. This study revealed the greatest formation of MDA in samples prepared in air fryer. Although pan frying is the main method applied for omelet preparation, other devices, such as microwave and air fryer, have attracted consumers' attention due to their practicality and convenience. Air fryers have shown a growing popularization, drawing attention to the results obtained in this study concerning their impact on egg lipids and also the protective effect of parsley, which was proved even in air-fried samples. Thus, the overall results suggest the use of parsley not only for culinary purposes but also as a viable practice to reduce lipid oxidation during the thermal preparation of eggs.

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