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Korrespondenzadresse:
asbabaoglu@selcuk.edu.tr

[1]) Department of Food Engineering, Agriculture Faculty, Selçuk University, Konya, Türkiye;
[2]) Department of Food Processing, Çumra Vocational School, Selçuk University, Konya, Türkiye

Assessment of garlic and onion powder as natural antioxidant on the physico-chemical properties, lipid-protein oxidation and sensorial characteristics of beef and chicken patties during frozen storage

Bewertung des Einflusses von Knoblauch- und Zwiebelpulver als natürliche Antioxidantien auf die physikalisch-chemischen Eigenschaften, die Lipid-Protein-Oxidation und die sensorischen Merkmale von Rind- und Hühnerfleischpasteten während der Gefrierlagerung

Ali Samet Babaoğlu[1]), Hatice Berna Poçan[2]), Tudi Ainiwaer[1]), Hayriye Özkan[1]),
Esra Korkmaz Mutlu[1]), Mustafa Karakaya[1])

Summary

The aim of this study was to evaluate the antioxidant effect of garlic and onion powder in beef and chicken patties during frozen storage for 120 days. Three different groups were produced for each type of meat (beef and chicken): beef and chicken patties without garlic and onion powder (control groups) (BC and CC), beef and chicken patties with garlic powder added at 0.70% (BG and CG), beef and chicken patties with onion powder added at 0.70% (BO and CO). The samples were analysed for pH, lipid and protein oxidation, colour and sensory properties. With the exception of the samples containing onion powder, the TBARS numbers of BC, CC, BG and CG increased during frozen storage and the highest TBARS numbers were determined on days 60, 90 and 120 ($P < 0.05$). The total protein carbonyl content of CG and CO did not change with the progression of frozen storage ($P > 0.05$). The addition of garlic powder preserved the a* value of beef patties during storage. The onion powder significantly improved oxidative stability by reducing TBARS number and total carbonyl content of beef and chicken patties ($P < 0.05$), while garlic powder had no significant effect on lipid and protein oxidation ($P > 0.05$). The beef patties with onion powder had a higher flavour score than the samples with garlic powder ($P < 0.05$). The garlic powder reduced the flavour and overall acceptance score of the chicken patties compared to the control group of chicken patties ($P < 0.05$). These results suggest that onion powder was an effective natural additive in terms of oxidative stability of beef and chicken patties and improved sensory properties.

Keywords: Meat products, natural antioxidants, oxidation, preservation

Introduction

Meat patties are regarded as one of the most popular prepared meat products, considering their high consumption rates, the simplicity of processing, rich nutrition and desirable flavour (Eshag Osman et al., 2021; Sun et al., 2021; Osman et al., 2022). Not only do beef and chicken patties consist of nutritional constituents such as protein and vitamins, but they also include essential fatty acids which are prone to oxidative degradation (Domínguez et al., 2019). Not to mention the fact that meat and meat products exposed to air, heat, or light trigger oxidation reactions which have negative impact on consumer acceptance because of undesirable changes in terms of colour, texture, appearance, odour and flavour (Purrinos et al., 2011; Amaral et al., 2018). For the purposes of preventing or delaying oxidation in meat and meat products, antioxidants have been used in the meat industry (Lishianawati and Yusiati, 2021). With respect to human health, however, consumers interrogate frequently and prolonged intake of synthetic antioxidants (Munekata et al., 2020a). Thus, the consumers are in tendency to consume plant-derived natural antioxidants (Manessis et al., 2020).

Garlic (*Allium sativum* L.) and onion (*Allium cepa* L.) have not only been used as natural culinary ingredient, but they also contain antioxidant compounds (Chung, 2006; Liguori et al., 2017). Sulphur-containing phytochemicals exist in garlic and onion (Mehta, 2014). Garlic contains antioxidant molecules such as flavonoids and phenolic compounds (Chung, 2006; Choi et al., 2014). Garlic includes important compounds such as alliin, diallylsulfide, allylsulfide and propylsulfide, which have antioxidant capacity (Bintoro et al., 2015; Škrovánková et al., 2018). Onion contains main phenolic components such as flavonols and anthocyanins and they have multi-functional health benefits including antioxidant, anti-inflammatory, antimicrobial, and anticancer effects (Bedrníček et al., 2020; Ren et al., 2020).

Although there are several studies on the addition of garlic in rabbit burgers (Mancini et al., 2020), black garlic powder on spent duck meat nugget (Lishianawati and Yusiati, 2021), garlic paste in raw chicken meat emulsion (Singh et al., 2014), crushed garlic in beef fat (Bintoro et al., 2015), garlic in beef sausage (Javed et al., 2011) and diced red onion in broiler chicken meat (Faluyi et al., 2020), there is a lack of study evaluating garlic and onion as natural antioxidants in beef and chicken meat patties simultaneously. In addition, no comprehensive evaluations of beef and chicken patties in frozen storage have been conducted. Therefore, the aim of the present study is to assess the effects of garlic and onion powders on lipid and protein oxidation, the physicochemical, colour and sensory properties of the beef and chicken patties during frozen storage for 120 days.

Material and methods

Materials

Biceps femoris of beef, beef fat, chicken breast muscles and chicken fat were obtained from a butcher in Konya, Türkiye, after 24 h postmortem. The garlic *(Allium sativum)* and onion (*Allium cepa* L.) were purchased from a greengrocer in Konya, Türkiye. The salt (Salina, Ankara, Türkiye) and breadcrumbs (Bagdat Baharat, Ankara, Türkiye) used in the preparation of patties were obtained from a market in Konya, Türkiye.

Preparation of garlic and onion powder

The skins of the garlic and onion were removed with a knife. The garlic and onion were cut into small pieces (3–5 mm) using a knife to shorten the drying time by reducing the surface area. They were then dried at room conditions (in a shady place, at a temperature of 23–24 °C and relative humidity 42–50%) for 96 h. The dried garlic and onion pieces were ground to obtain powder.

Preparation of beef and chicken patties

The proximate composition and pH value of the beef and chicken meats used in the production of patties were as follows: 68.82 ± 0.12% and 69.70 ± 0.20% moisture, 19.98 ± 0.19% and 21.68 ± 0.11% crude protein, 9.38 ± 0.32% and 7.14 ± 0.13% crude fat, 0.95 ± 0.06% and 1.10 ± 0.08% total ash, and 5.98 ± 0.02 and 6.16 ± 0.03 for pH values, respectively. The beef and beef fat and the chicken meat and chicken fat were ground twice with a 3 mm plate in a meat grinder (Kitchen Aid, Classic Model, USA). Three different groups of beef patties and three different groups of chicken patties were prepared, depending on the addition of natural additives: BC, without the addition of natural additives (control beef patties); BG, beef patties including garlic powder; BO, beef patties including onion powder; CC, without the addition of natural additives (control chicken patties); CG, chicken patties including garlic powder; and CO, chicken patties including onion powder. The formulations of the beef and chicken patties are shown in Table 1. When preparing the patties with garlic and onion powder, 0.7% of the breadcrumbs were replaced by garlic and onion powder in the formulation (Tab. 1). Minced meat groups (beef + beef fat and chicken meat + chicken fat) and the other ingredients (breadcrumbs, salt, water, garlic and onion powder) were weighed out as indicated in Table 1. They were then mixed together for 5 min and formed into patties in a petri dish (60 g per patty) to obtain an average size (about 9 cm in diameter and 0.6 cm thickness). The prepared patties were placed in polystyrene trays wrapped with PVC film (moisture permeability: 8 g/m^2 day; oxygen permeability: 15 cm^3/m^2 day atm) (Cook, Ankara, Türkiye) and stored at –18 °C for 120 days.

Experimental design

In the prepared garlic and onion powders, the total phenolic content (TPC), the total flavonoid content (TFC), the free radical scavenging activity (DPPH) and the ferric reducing ability of plasma (FRAP) were determined.

TABLE 1: *Formulation of beef and chicken patties.*

Formulation	Beef patties			Chicken patties		
	BC	BG	BO	CC	CG	CO
Meat* (%)	70.0	70.0	70.0	70.0	70.0	70.0
Animal fat** (%)	10.0	10.0	10.0	10.0	10.0	10.0
Water (%)	13.5	13.5	13.5	13.5	13.5	13.5
Salt (%)	1.5	1.5	1.5	1.5	1.5	1.5
Breadcrumb*** (%)	5.0	4.3	4.3	5.0	4.3	4.3
Garlic powder (%)	–	0.7	–	–	0.7	–
Onion powder (%)	–	–	0.7	–	–	0.7

* Beef was used in the BC, BG and BO groups, and chicken meat was used in the CC, CG and CO groups.
** Beef fat was used in the BC, BG and BO groups, and chicken fat was used in the CC, CG and CO groups.
***Some of the breadcrumb was substituted by garlic and onion powder. BC: control beef patties, BG: beef patties including garlic powder, BO: beef patties including onion powder, CC: control chicken patties, CG: chicken patties including garlic powder, CO: chicken patties including onion powder.

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Thirty patties per treatment were prepared in two independent replicates with triplicate sampling for analyses during frozen storage (–18 °C). Thirty patties were also prepared for sensory analysis. Analyses of pH, TBARS, total carbonyl and colour analyses were carried out on days 1, 30, 60, 90 and 120. Sensory analysis was only conducted on day 1. The frozen samples were thawed at 4 °C for 12 h before analyses.

Determination of TPC, TFC, DPPH and FRAP values

For the determination of TPC, TFC, DPPH and FRAP values, extracts were obtained from garlic and onion powders. Extracts were prepared according to the method of Hertog et al. (1992) with a slight modification. 40 mL methanol solution (62.5%) and 5 mL HCl solution (6.0 M) were added to 10 g garlic and onion powder. This mixture was kept at 80 °C for 2 h and then cooled to room temperature and filtered (Whatman No. 4).

The total phenolic content of the extracts obtained from garlic and onion powders was determined using the Folin-Ciocalteu method as described by Yoo et al. (2004). Absorbance was measured at 750 nm with a spectrophotometer (UV-160 A, UV-Visible Recording Spectrophotometer, Shimadzu, Tokyo, Japan). The results were expressed as mg gallic acid equivalents (GAE)/g. The total flavonoid content in the powders was determined according to the method reported by Chen and Chen (2011). Absorbance was measured at 510 nm using spectrophotometer. The results were expressed as mg catechin equivalents (CE)/g. The free radical scavenging activities of the powders were determined using DPPH (1,1-diphenyl-2-picrylhydrazyl) according to Lee et al. (1998). The absorbance at 517 nm was measured with a spectrophotometer. The results were expressed as µM Trolox/g. The antioxidant activities of garlic and onion powder were determined using the FRAP reagent according to de Rezende Mudenuti et al. (2021). Absorbance was recorded at 593 nm using a spectrophotometer. The results were given as nmol Fe (II) / g powder.

pH measurement

The pH values of the beef and chicken samples were measured with a pH meter (WTW pH-Metre 720, Weilheim, Germany) according to the method of Ockerman (1985).

Determination of TBARS number and total protein carbonyls

The TBARS number, used to measure the extent of lipid oxidation was measured according to the method given by Ockerman (1985). Absorbance values were measured spectrophotometrically at 530 nm. The TBARS number was calculated as mg malonaldehyde/kg sample.

To evaluate protein oxidation, the total carbonyl contents of beef and chicken patty samples were determined using the DNPH (2,4-dini trophenylhydrazine) method of Levine et al. (1994). The values obtained were expressed as mg protein/nmol carbonyl.

Colour evaluation

Colour measurements of the beef and chicken patties were measured with a colorimeter (Konica, Minolta CR 400, Osaka, Japan) with illuminant D65, 2° observer angle, diffuse/O mode and 8 mm aperture for illumination. L^* (lightness), a^* (redness), and b^* (yellowness) parameters were performed according to Hunt et al. (1991). Measurements were obtained from 5 different points for each sample and the results were reported as means of the values.

Sensory analysis

Sensory evaluation was conducted by 25 panellists of both gender who had the habit of patties consumption. Beef and chicken patties were cooked in an electric grill at 180°C for 13 min. The cooked samples were cooled down at room temperature and encoded in three-digit numbers randomly. Six patties of 1 from each group were served to the panellists with water and bread in one session. A 9-point hedonic scale, varying from dislike extremely (score 1) to like extremely (score 9), was used. Each panellists evaluated the various characteristics of patties samples (appearance, odour, texture, flavour and overall acceptance) according to the scale given to them. In the evaluation of the results, the averages of the scores given for each group were taken (Tseng et al., 2000).

Statistical analysis

For the statistical analysis of the pH, TBARS, total carbonyl and colour values, a one-way analysis of variance was performed out separately for beef and chicken patties using the programme MINITAB version 16.0. Natural additive treatment (garlic and onion powder), storage days (1, 30, 60, 90 and 120 days) and their interaction were considered as fixed factors, while beef and chicken meat were analysed as random factor. Tukey Multiple Comparison Tests were used to determine differences between means at a 5% significance level.

Results and discussion

Antioxidative properties of garlic and onion powder

Table 2 shows the content of total phenolic (TPC), total flavonoid (TFC), antioxidant activity (DPPH) and ferric reducing antioxidant power (FRAP) in garlic and onion powder. TPC and TFC were higher in onion powder than in garlic powder ($P < 0.05$). Onion powder also had higher DPPH and FRAP values than garlic powder. A correlation was observed between high DPPH and FRAP results and high levels of total phenols and total flavonoids in the onion extracts. These results are in line with Priecina and Daina (2013) and Soto et al. (2015), who reported that onions have higher TPC, TFC and antioxidant activity values than garlic.

pH values

The changes in pH values of the beef and chicken patties during frozen storage are presented in Table 3. The pH values of the beef patties did not change with the progression of frozen storage ($P > 0.05$). The lowest pH value was recorded in the control group on day 1 of storage. The effect of adding garlic and onion powder on the pH values

TABLE 2: *TPC, TFC, DPPH and FRAP values of garlic and onion powder.*

Extracts	TPC (mg GAE/g dry matter)	TFC (mg CE/g dry matter)	DPPH (µM Trolox/g dry matter)	FRAP (nmol Fe(II)/g)
Garlic powder	0.72 ± 0.05[b]	0.26 ± 0.01[b]	6.81 ± 0.78[b]	6.01 ± 0.15[b]
Onion powder	2.86 ± 0.05[a]	3.76 ± 0.11[a]	12.66 ± 0.14[a]	17.07 ± 0.19[a]

Mean ± std. deviation. Different lower-case letters (a-b) in the same column indicate significant differences (P < 0.05). TPC: total phenolic content; TFC: total flavonoid content; DPPH: 2,2-diphenyl-1-picrylhydrazyl scavenging assay; FRAP: ferric reducing antioxidant power.

TABLE 3: *pH, TBARS and total protein carbonyl values of samples during frozen storage for 120 days.*

Parameters	Storage periods	BC (Beef patties)	BG (Beef patties)	BO (Beef patties)	CC (Chicken patties)	CG (Chicken patties)	CO (Chicken patties)
pH							
	Day 1	5.97 ± 0.01^{Ab}	6.07 ± 0.01^{Aa}	6.03 ± 0.01^{Aa}	6.16 ± 0.01^{Ba}	6.29 ± 0.01^{Aa}	6.27 ± 0.04^{Aa}
	Day 30	5.96 ± 0.01^{Aa}	6.05 ± 0.03^{Aa}	6.01 ± 0.02^{Aa}	6.23 ± 0.01^{ABab}	6.26 ± 0.01^{ABa}	6.19 ± 0.01^{Ab}
	Day 60	5.96 ± 0.01^{Aa}	6.02 ± 0.02^{Aa}	6.00 ± 0.01^{Aa}	6.21± 0.01^{Ba}	6.23 ± 0.01^{Ba}	6.20 ± 0.01^{Aa}
	Day 90	5.96 ± 0.01^{Aa}	5.98 ± 0.02^{Aa}	5.97 ± 0.03^{Aa}	6.18 ± 0.01^{Bb}	6.24 ± 0.01^{Ba}	6.20 ± 0.01^{Aab}
	Day 120	6.03 ± 0.02^{Aa}	6.04 ± 0.01^{Aa}	6.04 ± 0.01^{Aa}	6.29 ± 0.03^{Aa}	6.29 ± 0.01^{Aa}	6.24 ± 0.01^{Aa}
TBARS number (mg MA/kg sample)							
	Day 1	0.44 ± 0.05^{Ba}	0.41 ± 0.01^{Ba}	0.23 ± 0.01^{Bb}	0.16 ± 0.04^{Ba}	0.19 ± 0.01^{Ba}	0.16 ± 0.02^{Aa}
	Day 30	0.97 ± 0.01^{Bab}	1.92 ± 0.30^{Aa}	0.29 ± 0.02^{ABb}	0.23 ± 0.03^{Ba}	0.34 ± 0.05^{Ba}	0.22 ± 0.05^{Aa}
	Day 60	2.06 ± 0.22^{Aa}	2.40 ± 0.18^{Aa}	0.45 ± 0.04^{ABb}	0.48 ± 0.01^{Ab}	0.86 ± 0.02^{Aa}	0.31 ±0.08^{Ab}
	Day 90	2.27 ± 0.20^{Aa}	2.43 ± 0.12^{Aa}	0.51 ± 0.08^{Ab}	0.56 ± 0.04^{Aa}	0.69 ± 0.02^{Aa}	0.34 ± 0.11^{Ab}
	Day 120	2.40 ± 0.12^{Aa}	2.40 ± 0.11^{Aa}	0.55 ± 0.06^{Ab}	0.56 ± 0.05^{Aa}	0.71 ± 0.05^{Aa}	0.59 ± 0.13^{Aa}
Protein carbonyl content							
	Day 1	2.50 ± 0.03^{Ca}	2.37 ± 0.14^{Ba}	1.08 ± 0.11^{Bb}	2.42 ± 0.13^{Ba}	2.54 ± 0.02^{Aa}	1.10 ± 0.23^{Ab}
	Day 30	3.15 ± 0.08^{BCa}	2.87 ± 0.30^{ABa}	1.31 ± 0.17^{Bb}	3.85 ± 0.09^{ABa}	3.70 ± 0.44^{Aa}	1.49 ± 0.38^{Ab}
	Day 60	3.21 ± 0.18^{BCa}	3.37 ± 0.51^{ABa}	1.68 ± 0.22^{ABb}	4.05 ± 0.44^{ABa}	4.17 ± 0.37^{Aa}	1.55 ± 0.38^{Ab}
	Day 90	3.84 ± 0.13^{Ba}	3.67 ± 0.04^{ABa}	1.93 ± 0.28^{ABb}	4.70 ± 0.47^{Aab}	4.82 ± 0.61^{Aa}	2.20 ± 0.07^{Ab}
	Day 120	4.79 ± 0.23^{Aa}	4.63 ± 0.38^{Aa}	2.75 ± 0.32^{Ab}	5.00 ± 0.53^{Aa}	5.01 ± 0.58^{Aa}	2.40 ± 0.09^{Ab}

* Mean ± std. error. Different capital letters (A–B) in the same column and lower-case letters (a-b) in the same row indicate significant ($P < 0.05$) differences. (BC: control beef patties, BG: beef patties including garlic powder, BO: beef patties including onion powder, CC: control chicken patties, CG: chicken patties including garlic powder, CO: chicken patties including onion powder)

of the beef patties was not significant ($P > 0.05$). Similarly, Park et al. (2008) reported that garlic and onion powders had no effect on pH values during storage of fresh pork belly and loin.

The pH values of the control samples of chicken patties increased with the progression of frozen storage progressed ($P < 0.05$), while there were fluctuations in pH values of chicken patties containing garlic powder (CG) in frozen storage ($P < 0.05$). The pH value of the chicken patties with onion powder (CO) did not change significantly during the frozen storage ($P > 0.05$). The increase in the pH value of CC with increasing storage time is attributed to the formation of basic compounds (amines and other compounds) through autolysis (especially lipid oxidation) and microbial activity (Binsi et al. 2007). It is thought that the higher antioxidant activity of onion in CO prevents lipid oxidation (TBARS number) (Tab. 3) and keeps the pH of the samples stable during frozen storage. The fact that garlic is not as effective as onion in lipid oxidation supports the fluctuations in the pH values of the group CG. In terms of garlic and onion powder treatment, the lowest pH value in CO was determined on the 30th day, while the lowest pH value in the control group was determined on the 90th day. Our results agree with the findings of Sallam et al. (2004), in which pH values of the chicken sausage samples increased during storage. Moawad et al. (2020) also pointed out that garlic extracts lead to an increase in the pH of fish patties during storage.

Lipid oxidation

The changes in TBARS numbers of beef and chicken patties during 120 days of frozen storage are given in Table 3. TBARS numbers of beef patties increased with the progression of frozen storage ($P < 0.05$). Beef patties containing onion powder had significantly lower TBARS than BC and BG ($P < 0.05$). The TBARS numbers of the BC group varied between 0.44 and 2.40 mg MA/kg sample and between 0.41 and 2.40 mg MA/kg sample in the BG group, while the numbers of the BO group varied between 0.23 and 0.55 mg MA/kg sample on day 1 and 120 (Tab. 3). The onion powder thus reduced the TBARS count compared to the control and garlic powder added samples ($P < 0.05$).

The TBARS numbers of CC and CG increased with the progression of frozen storage ($P < 0.05$), while onion powder protected the chicken patties from lipid oxidation by keeping their TBARS numbers stable during 120 days of frozen storage ($P > 0.05$). On day 90, the lowest TBARS value was determined in chicken patties with onion powder.

In our study, the reason why onion powder was more effective than garlic powder on lipid oxidation in both beef and chicken patties can be attributed to the higher antioxidant properties (TPC, TFC, DPPH and FRAP) of onion powder compared to garlic powder (Tab. 2) ($P < 0.05$). Our TBARS results from samples that contained onion powder are consistent with the results of Tang and Cronin (2007) on pickled onion extracts in cooked turkey breast rolls and Jayawardana et al. (2019) on cooked pork sausages with different concentrations of onion powder. On the other hand, the increase in our TBARS numbers during frozen storage is consistent with the study by Moawad et al. (2020), which evaluated the quality of fish cakes with garlic and ginger extract during storage. An increase in TBARS numbers during storage was also observed by Dewa and Huda (2014) in samples of duck sausage with garlic powder.

In this study, the TBARS numbers of beef patties were higher than those of chicken patties. This difference could be due to the fat content of the different meats, the degree of saturation of the fat and the original malonaldehyde content of the meat.

If the TBARS level in meat products is 0.7 or more, a rancid taste is sensory, and if it is 1 mg/kg or more, it cannot be consumed due to the rancid taste in meat products (Ockerman, 1985). In our study, the beef patties exceeded the threshold for TBARS content after day 30, while all chicken patties remained below the threshold for TBARS throughout frozen storage (Tab. 3).

Total protein carbonyls

The changes in the total protein carbonyl contents of beef and chicken patties during frozen storage for 120 days are shown in Table 3. The total protein carbonyl contents of the beef patties increased as the frozen storage progressed, and the highest total protein carbonyl amounts were determined on the 120th day of storage ($P < 0.05$). The lowest total protein carbonyl content was found in beef patties with onion powder (BG) in all frozen storage periods ($P < 0.05$). The garlic powder had no effect on the total protein carbonyl content compared to the control samples ($P > 0.05$). Similarly, Kim et al. (2019) reported that the use of 1% fresh garlic and 0.5% aged garlic powder had no antioxidant effect on protein oxidation in pork patties.

While the total protein carbonyl content of the control group (CC) increased during frozen storage ($P < 0.05$), no significant change in the total protein carbonyl content was observed in the chicken patties to which garlic and onion powder was added as frozen storage progressed ($P > 0.05$). The lowest total protein carbonyl content was found in chicken patties with onion powder in all storage periods ($P < 0.05$).

In our study, onion powder was more effective than garlic powder on total carbonyl content in the both beef and chicken patties and on lipid oxidation. This can also be attributed to the higher antioxidant properties of onion powder compared to garlic powder ($P < 0.05$). Additionally, it has been reported that the products formed as a result of lipid oxidation lead to the formation of Schiff base adducts and subsequent co-oxidation of proteins (Wang et. al., 2019). In parallel, the lower lipid oxidation level of the samples with onion powder in our study also supports the lower total carbonyl content of these groups.

Colour properties

The mean colour values *(L*, a*, b*)* of the beef and chicken patties with garlic and onion powder during frozen storage (120 days) are presented in Table 4. The *L** values of both beef and chicken patties did not change significantly during frozen storage ($P > 0.05$). However, it was found that the CG had the highest *L** values only on day 30. With regard to the *L** values, a similar results was confirmed by Akarpat et al. (2008) who used various plant extracts in beef patties for 120 days storage time. A similar trend in *L** values was tabled by Kim et al. (2019) who used fresh garlic powder in pork patties.

During storage, *a** values of beef patties decreased in control groups, while garlic addition preserved *a** values. The decrease in *a** values of meat and meat products during storage has been previously reported (Sánchez-Escalante et al., 2003; Fernandez-Lopez et al., 2005). The colour of frozen meat turns dark red-brown as a result of the combination of surface drying and metmyoglobin formation (Hui et al., 2001). In addition, it is reported that colour change occurs with the formation of various oxidative reactions during storage in meat and meat products (Munekata et al., 2020b). In this study, it was determined that the addition of garlic powder to beef patties was effective in reducing and delaying the red discoloration of the samples. It was also determined that the *a** values of CO and CC did not change during the storage period.

When the *b** values of the patties were examined, it was observed that the *b** values of the samples in all groups except BG did not change during the storage period. However, it was determined that CO had the highest *b** value in chicken patties on the 90th and 120th days.

Sensory scores

Garlic (*Allium sativum* L.) and onion (*Allium cepa* L.) are two important spices often used in cooking to complement and enhance the flavour of meat products (Tang and Cronin, 2007). Figure 1 indicates the sensory scores (appea-

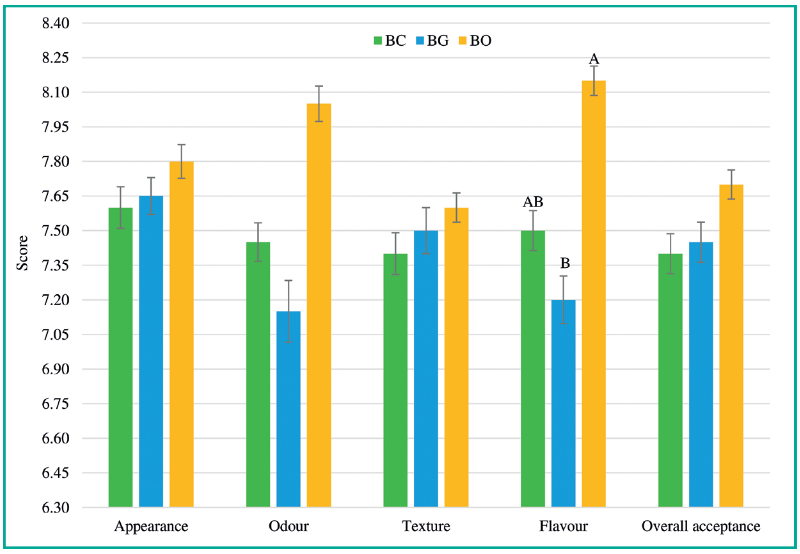

FIGURE 1: *The sensory scores of beef patties. Different capital letters (A–B) in the flavour scores indicate significant (P < 0.05) differences. (BC: control beef patties, BG: beef patties including garlic powder, BO: beef patties including onion powder).*

TABLE 4: *L*, a* and b* values of samples during frozen storage for 120 days.*

Colour parameters	Storage periods	Beef patties BC	BG	BO	Chicken patties CC	CG	CO
*L**	Day 1	44.60 ± 0.88^{Aa}	43.51 ± 0.54^{Aa}	43.89 ± 0.04^{Aa}	55.91 ± 0.65^{Aa}	57.24 ± 0.37^{Aa}	55.86 ± 0.62^{Aa}
	Day 30	44.34 ± 0.70^{Aa}	44.75 ± 0.67^{Aa}	43.63 ± 0.94^{Aa}	55.99 ± 0.08^{Ab}	56.42 ± 0.04^{Aa}	55.09 ± 0.02^{Ac}
	Day 60	43.72 ± 0.82^{Aa}	44.56 ± 0.73^{Aa}	44.02 ± 1.47^{Aa}	56.03 ± 0.30^{Aa}	56.91 ± 0.62^{Aa}	55.29 ± 0.74^{Aa}
	Day 90	44.54 ± 0.72^{Aa}	43.44 ± 0.53^{Aa}	43.75 ± 1.17^{Aa}	55.76 ± 0.79^{Aa}	56.80 ± 0.57^{Aa}	54.51 ± 0.13^{Aa}
	Day 120	45.66 ± 0.34^{Aa}	43.94 ± 0.10^{Ab}	42.48 ± 0.24^{Ac}	56.16 ± 0.24^{Aa}	56.54 ± 0.07^{Aa}	55.85 ± 0.44^{Aa}
*a**	Day 1	15.69 ± 0.48^{Aa}	9.96 ± 0.01^{Ab}	9.78 ± 0.48^{Ab}	3.22 ± 0.10^{Aa}	2.07 ± 0.16^{ABb}	2.17 ± 0.05^{Ab}
	Day 30	12.66 ± 0.37^{Ba}	7.35 ± 0.52^{Ab}	8.73 ± 0.15^{ABb}	3.44 ± 0.15^{Aa}	2.28 ± 0.06^{Ab}	2.15 ± 0.20^{Ab}
	Day 60	10.78 ± 0.25^{Ca}	7.26 ± 0.91^{Aa}	8.13 ± 0.60^{ABa}	3.00 ± 0.13^{Aa}	1.93 ± 0.13^{ABa}	2.17 ±0.38^{Aa}
	Day 90	9.36 ± 0.01^{CDa}	7.64 ± 0.72^{Aa}	7.51 ± 0.06^{Ba}	3.11 ± 0.13^{Aa}	1.69 ± 0.06^{BCb}	2.27 ± 0.16^{Ab}
	Day 120	8.32 ± 0.20^{Da}	8.81± 0.03^{Aa}	8.14 ± 0.13^{ABa}	2.85 ± 0.25^{Aa}	1.29 ± 0.07^{Cb}	1.96 ± 0.03^{Ab}
*b**	Day 1	10.88 ± 0.04^{Aa}	11.16 ± 0.54^{ABa}	10.77 ± 0.55^{Aa}	12.51 ± 0.03^{Aa}	13.13 ± 0.41^{Aa}	12.84 ± 0.15^{Aa}
	Day 30	10.63 ± 0.86^{Aa}	11.26 ± 0.41^{ABa}	10.85 ± 0.19^{Aa}	12.38 ± 0.24^{Aa}	12.89 ± 0.12^{Aa}	13.28 ± 0.23^{Aa}
	Day 60	11.45 ± 0.35^{Ab}	13.28 ± 0.23^{Aa}	11.56 ± 0.06^{Ab}	13.02 ± 0.32^{Aa}	12.82 ± 0.19^{Aa}	14.08 ± 0.56^{Aa}
	Day 90	11.24 ± 0.42^{Aa}	11.05 ± 0.05^{Ba}	10.34 ± 0.58^{Aa}	12.12 ± 0.44^{Ab}	12.92 ± 0.04^{Aab}	13.96 ± 0.02^{Aa}
	Day 120	11.79 ± 0.30^{Aa}	12.27 ± 0.45^{ABa}	10.16 ± 0.35^{Aa}	12.87 ± 0.08^{Ab}	12.99 ± 0.03^{Ab}	14.28 ± 0.06^{Aa}

Mean ± std. error. Different capital letters (A–B) in the same column and lower-case letters (a-b) in the same row indicate significant ($P < 0.05$) differences. (BC: control beef patties, BG: beef patties including garlic powder, BO: beef patties including onion powder, CC: control chicken patties, CG: chicken patties including garlic powder, CO: chicken patties including onion powder)

Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

rance, odour, texture, flavour and overall acceptance) of beef patties. While the addition of garlic and onion did not affect the appearance, odour, texture and overall acceptance ($P > 0.05$), flavour scores of beef patties were significantly different ($P < 0.05$). The group BO had a higher flavour score compared to BG ($P < 0.05$).

Figure 2 shows the effects of garlic and onion powder on the sensory scores of chicken patties. As can be seen in Figure 2, garlic and onion powder had no effect on the appearance, odour and texture of the chicken patties ($P > 0.05$). Flavour and overall acceptance scores of chicken patties were significantly different ($P < 0.05$). For both flavour and overall acceptance, the garlic powder reduced the scores of the chicken patties compared to the control group ($P < 0.05$). In both the beef and chicken patties, the garlic powder had a negative effect on the flavour of the samples. A possible explanation for these results may be the reason that garlic powder contains intense sulphur compounds. It has been reported that the organosulphur compounds and their precursors in garlic such as allicin, diallyl sulphide and diallyl trisulphide are the main compounds responsible for the smell and flavour of garlic (Kim et al., 2009). Allicin is the sulphurous essential oil that gives garlic its special smell and taste. The presence of allicin is easily recognised due to its pungent odour and flavour (Izigov et al., 2011). Another explanation for the intense garlic flavour could be the amount of garlic powder added. Yang et al. (2011) indicated that the addition of 0.1% garlic or 0.1% garlic + 0.5% onion significantly reduced the intensity of the sulphur aroma in irradiated raw minced meat. Our results are consistent with those of Mancini et al. (2020), who found that garlic powder reduced the flavour scores of cooked rabbit meat burgers. However, in contrast to our study results, the addition of garlic improved sensory properties in studies with pork (Kim et al., 2010) and pork meatballs (Kim et al., 2019). Furthermore, there are also studies in which garlic powder does not affect the flavour score compared to the control group (without garlic) (Horita et al., 2016; Lishianawati and Yusiati, 2021).

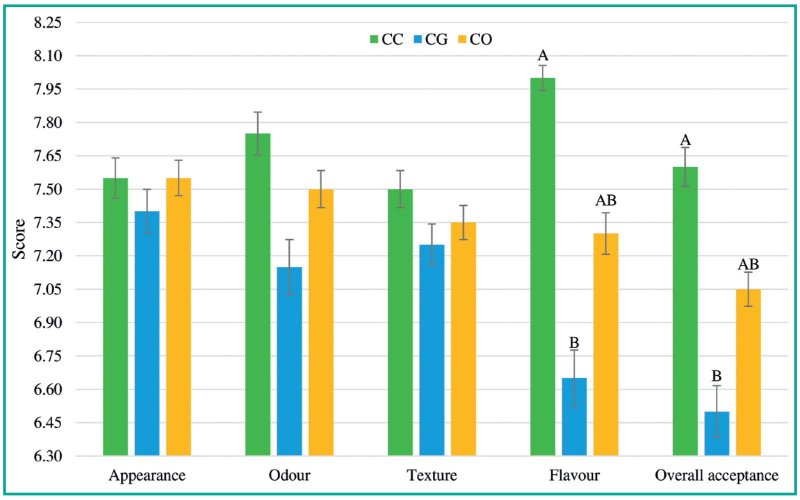

FIGURE 2: *The sensory scores of chicken patties. Different capital letters (A–B) in the flavour and overall acceptance scores indicate significant ($P < 0.05$) differences. (CC: control chicken patties, CG: chicken patties including garlic powder, CO: chicken patties including onion powder).*

In our study, the negative effect of garlic powder on taste was greater in chicken patties than in beef patties. This may be due to the fact that the meat flavour is more intense than the chicken flavour and therefore masks the garlic flavour so that it is not as noticeable as with chicken.

Conclusions

In the present study, the lipid and protein oxidation levels, as well as some physicochemical and sensory properties of beef and chicken patties with the addition of garlic and onion powder were investigated. Onion powder had a higher total phenolic and total flavonoid content, and higher DPPH and FRAP values than garlic powder. Our findings show that the addition of onion powder to beef patties has an inhibitory effect on lipid and protein oxidation during frozen storage. In chicken patties, the addition of onion powder showed an antioxidant effect against the protein oxidation, while on the 60th and 90th day of storage, the addition of onion powder showed an antioxidant effect against the oxidation of proteins during frozen storage. Garlic powder added to beef patties during storage preserved the a* value of the samples. Onion powder showed the highest b* value in chicken patties at the end of storage. The addition of onion powder improved the flavour score of the beef patties. As a result, the use of onion powder in frozen stored beef and chicken can be recommended as a natural preservative, as it delays oxidation and improves the taste of the product.

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Conflict of Interest

Authors declare no conflict of interest.

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Address of corresponding author:
Ali Samet Babaoğlu
Department of Food Engineering
Agriculture Faculty
Selçuk University
Konya
Türkiye
asbabaoglu@selcuk.edu.tr

+++ Nachrichten aus Forschung, Politik und Industrie +++

(Die Verantwortlichkeit für die Texte liegt ausschließlich bei den Instituten, Ministerien und werbenden Unternehmen.)

Genforschung

Neue Erkenntnisse zum Schweinevirus PRRS

Eine soeben erschienene Studie der Veterinärmedizinischen Universität Wien liefert neues Wissen zur Genexpression nach einer PRRS-Infektion. Ein besseres Verständnis der Immunantworten kann zu einer gezielten Entwicklung wirksamer Impfstoffe und damit zum Schutz vor der gefährlichen Viruserkrankung beitragen.

Das RNA-Virus PRRS (Porcine Reproductive and Respiratory Syndrome) verursacht bei Schweinen leichte bis schwere klinische Symptome der Atemwege und der Fortpflanzung. Das Problem: Eine Veränderung der Immunantwort des Wirts durch PRRS ist mit einer erhöhten Anfälligkeit für sekundäre virale und bakterielle Infektionen verbunden, was zu noch schwerwiegenderen Erkrankungen führt. Allerdings sind die Expressionsprofile, die den angeborenen und adaptiven Immunantworten auf eine PRRS-Infektion zugrunde liegen, bisher noch weitgehend unbekannt.

Wichtiger Beitrag zur Entwicklung von Impfstoffen

In ihrer Studie untersuchte das Wissenschaftsteam der Vetmeduni um Studien-Erstautor Emil Lagumdzic vom Institut für Immunologie und Studien-Letztautor Armin Saalmüller, Leiter des Instituts für Immunologie, deshalb die Genexpressionsprofile von PBMC-Blutzellen und CD8+-T-Zellen nach einer PRRS-Infektion. „Die umfangreichen Transkriptomdaten helfen, die Gensignaturen der Immunantwort von PBMCs und CD8+-T-Zellen nach einer PRRS-Infektion zu erklären. Darüber hinaus liefert unsere Studie potenzielle Biomarker-Ziele, die für die Entwicklung von Impfstoffen und Therapeutika nützlich sind", erklärt Emil Lagumdzic. Bereits vor Veröffentlichung der Studie holte sich Emil Lagumdzic für seine Arbeit den renommierten PRRS-Forschungspreis 2022 von Boehringer-Ingelheim. Das Pharmaunternehmen vergibt jährlich drei Awards, um praktische Methoden zur Kontrolle des PRRSV zu unterstützen und die wissenschaftliche Expertise zu stärken. Die Gewinner:innen werden von einer unabhängigen Jury aus Mitgliedern der gesamten Schweinepraxis und Wissenschaft gewählt.

PRRS – gefährliche Viruserkrankung von Schweinen mit hohem wirtschaftlichem Schaden

PRRS trat in Europa und den USA erstmals in den späten 1980er Jahren auf. Mit der Krankheit sind für die Schweinezucht hohen Kosten in Milliardenhöhe verbunden. Zur Eindämmung des Virus sollen neben Impfungen neuartige, praxisnahe Methoden zum Schutz vor PRRS beitragen.

Weitere Informationen (Quelle):
Veterinärmedizinische Universität Wien |
www.vetmeduni.ac.at

Eine neue Entdeckung

Zucker-Origami – Gefaltete Zuckerstrukturen

Forscherinnen und Forscher am Max-Planck-Institut für Kolloid- und Grenzflächenforschung (MPIKG) haben ein Kohlenhydrat entworfen, das sich selbst in eine bestimmte Form falten kann. Bisher waren solche selbst faltenden Biopolymere nur für DNA und Eiweiße entwickelt worden und Zucker galten bisher als zu flexibel, um eine stabile Form annehmen zu können. Gefaltete Zucker könnten in der Biomedizin und in der Materialentwicklung völlig neue Perspektiven eröffnen.

Kohlenhydrate machen etwa 80 % der Biomasse auf der Welt aus – die Hälfte an Land und die Hälfte im Meer. Dennoch sind ihre Materialeigenschaften noch recht wenig erforscht. Die Forscherinnen und Forscher um Dr. Martina Delbianco, aus der Abteilung für Biomolekulare Systeme, untersuchen, wie sich Polysaccharide, also lange Zuckerketten, falten und zu Materialien zusammensetzen. So haben sie beispielsweise herausgefunden, wie sich einzelne Glukoseketten zu Fasern vereinigen und dies im Detail untersucht. Auf der Grundlage dieses Wissens entwerfen sie nun nicht-natürliche Kohlenhydrate. Inspiriert ist ihre Arbeit von der Peptidforschung. Nach dem Vorbild natürlicher Eiweiße wurden diese synthetisch so gestaltet, dass sie bestimmte 3D-Formen annehmen und bestimmte Funktionen erfüllen können. Dieser Ansatz eröffnete neue Möglichkeiten, z. B. in der Medikamentenherstellung.

In ihrer jüngsten Veröffentlichung im Fachjournal Nature Chemistry haben Dr. Delbianco und ihr Team gezeigt, dass es möglich ist, Zucker zu entwickeln, die in wässriger Lösung eine bestimmte stabile Anordnung annehmen. Sie verknüpften natürliche Zuckermotive miteinander und erzeugten eine Form, die in der Natur nicht vorkommt: eine Haarnadel. In einem Lego-ähnlichen Ansatz verbanden sie zwei lineare Zellulosestäbe mit einer starren Glykanwindung, um eine neue, nicht natürliche Form zu erhalten. „Kohlenhydrate können so programmiert werden, was die Möglichkeit eröffnet, Glykane mit neuen Eigenschaften und Funktionen auszustatten," sagt Dr. Martina Delbianco. Die Struktur wurde mit Hilfe eines „Zuckersyntheseautomaten", der einzelne Zuckerbausteine miteinander verbindet, um maßgeschneiderte Polymere zu erzeugen. Um deren 3-D-Struktur aufzudecken, setzte die Arbeitsgruppe eine Vielzahl von Analysetechniken ein. Darüber hinaus haben internationale Wissenschaftler, wie Prof. Jesús Jiménez-Barbero vom CIC BioGUNE mit Dr. Martina Delbianco zusammengearbeitet: „Die 3-D-Struktur eines Biomoleküls bestimmt seine Funktion. In Zukunft könnten wir gefaltete Zucker als Medikamente, Katalysatoren für chemische Umwandlungen oder Struktureinheiten für die Herstellung von Nanomaterialien verwenden."

Weitere Informationen (Quelle):
Max-Planck-Institut für Kolloid- und Grenzflächenforschung |
www.mpikg.mpg.de