J. Meat Sci. 2022, 17(2): 42-50

Research Article

ACS Publisher
www.acspublisher.com

Journal of Meat Science

Year 2022 (December), Volume-17, Issue-2

ISSN 0975-5209 *(Print)*
ISSN 2581-6616 *(Online)*

Functional Low Fat Chicken Meat Balls Enriched with Grape (Vitis Vinifera) Pomace Powder

D.Santhi[a*] A.Kalaikannan[b] and A.Elango[c]

[a]Veterinary College and Research Institute, Orathanadu
[b]Regional Research and Educational Centre (RREC), Pudukkottai
[c]Veterinary College and Research Institute, Salem
Tamil Nadu Veterinary and Animal Sciences University, India.

ARTICLE INFO

- *Corresponding author.
- *E-mail address:* drdshanthitanuvas@gmail.com (D.Santhi)

Received 17-06-2022; Accepted 30-10-2022

DOI: 10.48165/jms.2022.170207

ABSTRACT

This study was conducted to prepare low fat chicken meat balls with incorporation of grape (*Vitis vinifera*) pomace powder and assess its proximate composition, physico-chemical, sensory and textural properties. Emulsion based low fat chicken meat balls were prepared with the addition of grape pomace powder (GPP) at levels of 2% (GPP2), 4% (GPP4) and 6% (GPP6), over and above the amount of meat along with a control (GPP0). There was a significant (P≤0.05) increase in the crude fibre, total ash and gross energy levels of GPP4 and GPP6. In the physico-chemical properties, the emulsion pH and product pH significantly (P≤0.05) decreased with increase in the GPP content. In sensory evaluation, the scores for appearance and colour, flavour, juiciness, tenderness and overall acceptability were significantly (P≤0.01) reduced for GPP6. Though the scores of GPP2 and GPP4 were significantly (P≤0.05) lower than that of GPP0, the scores were above the acceptable level. The textural properties of the chicken meat balls significantly (P≤0.05) changed with the addition of GPP. It can be concluded that emulsion based functional low fat chicken meat balls could be enriched with an optimum level of 4% of grape pomace powder without affecting the quality characteristics, thus enhancing the dietary fibre content and antioxidant efficacy of the chicken meat balls.

Key words: Chicken meat balls, Grape pomace powder, Dietary fibre, Proximate composition, Physico-chemical properties, Sensory Properties, Textural properties.

INTRODUCTION

Chicken is one of the favorite delicacies at present due to more amounts of unsaturated fatty acids and absence of any religious taboos. Yet, meat eaters are more vigilant about the consumption of meat with the misconception that meat is not good for health. The American Heart Association Dietary Guidelines recommend that an aver-

[#]This Research article is a part of the Ph.D. Thesis submitted by the first author to the Tamil Nadu Veterinary and Animal Sciences University, Chennai.

age 15% of the total energy should be met by protein, and the consumption of a diet that contains a variety of foods from all the food categories is healthy. Fortifying chicken meat products with dietary fibre from various sources such as cereals, pulses, legumes, fruits, vegetables will improve the dietary fibre content (Santhi *et al*., 2020; Santhi *et al*., 2022). This study was conducted to prepare low fat chicken meat balls with incorporation of grape (*Vitis vinifera*) pomace powder and assess its physico-chemical and sensory properties.

Grape pomace is one of the vital by-product obtained in the process of grape juice preparation and winemaking. Over 60 per cent of the grape pomace dry matter is composed of dietary fibre (non-starch polysaccharides plus lignin) as well as condensed tannins and resistant protein, which would provide grape pomace with peculiar physiological and nutritional properties (Bravo and Saura-Calixto, 1998; Yavruyan and Avetisyan, 2021).Seedless grape skin powder was found to contain 12.91% of fibre (Mostafa *et al*., 2022). Pomace of different grape varieties has been shown to contain high concentrations of pectin and phenolic substances (Ageyeva *et al*., 2021). The beneficial effect of a grape pomace extract, as an antioxidant has been demonstrated by Bekiari *et al*. (2022). The insoluble residues of the grape pomace from ten grape varieties had lignin content ranging from 16.8% to 24.2%, and the peptic substances ranging from 37% to 54% of cell wall polysaccharides, and hence grape pomace was suggested as a potential dietary fibre source of good quality (Gonzalez-Centeno *et al*., 2010).

In the global scenario of poultry meat production, India finds place as one of the leading producers. The increase in the average income and the urban population has led to a tremendous increase in the poultry demand and a steady increase in consumption over the years. In 2021, the consumption of poultry meat in India was found to be over four million metric tons (Statista Research Department, 2022). Healthcare specialists have vouched for rich protein intake and chicken being an excellent source of protein has become a staple diet for consumers across age groups. Non-vegetarians have increased their chicken consumption to twice a week on average from once in 10 days earlier as they look to increase protein intake amid Covid-19 pandemic. Demand for protein-rich food items value-added meat products like chicken nuggets, sausages, and salami has also surged, as a high-protein diet is recommended to speed up recovery from Covid-19 infection and to boost immunity. One of the main reasons for the surge in consumption of ready-to-cook and value-added foods is the convenience factor – there is low involvement in terms of time and effort taken to prepare the meal (The Economic Times, 2022).

In earlier research studies, grape pomace powder (GPP) had been used as a functional ingredient in many food products such as frankfurters (Ozvural and Vural, 2011), beef hamburgers (Abdelhakam *et al*., 2019), Chicken nuggets (Cagdas and Kumcuoglu, 2015), biscuits (Mildner-Szkudlarz *et al*., 2013; Lou *et al*., 2021), cookies (Kuchtova *et al*., 2018), chocolate (Bursa *et al*., 2021) bread sticks (Rainero *et al*., 2022), wafer sheets (Altinok *et al*., 2022) and sausages (Zahran, 2021).The present study was conducted to fortify low fat chicken meat balls with GPP as dietary fibre source and to assess its proximate composition, physico-chemical, sensory and textural properties, thus optimizing the level of inclusion of GPP in the chicken meat balls.

MATERIALS AND METHODS

Source of Raw Materials

Broiler meat: Dressed broiler carcasses were purchased from the retail outlets of Namakkal town, packed in fresh polyethylene bags and transported in thermo cool box to the Department of Livestock Products Technology Technology (Meat Science), Veterinary College and Research Institute, Namakkal. The carcasses were hygienically deboned and trimmed of all visible adipose and connective tissues at the department laboratory. The deboned meat was minced through an 8-mm plate using a meat mincer (Junior MEW 510, MADO, Germany) packaged in low-density polyethylene (LDPE) and stored in the laboratory freezer at -18±2^{o}C for subsequent use in the experiments.

Grape pomace powder (GPP) - Fresh black grapes (*Vitis vinifera*) were purchased in bunches from local market. The grape fruits were processed by detaching from the stem, rinsing thoroughly, draining and crushing in a juice extractor to obtain the juice and the pomace. The pomace was then dried in hot air oven by placing them on a drying tray at 60°C for 16 hours, ground to a flour, sieved to a fine powder with a 0.45 mm diameter stainless steel mesh and stored at room temperature for use in the experiments.

Spice mix Formulation: The spices were weighed and ground to fine powder as per the following composition expressed in percent (Coriander-40, Cumin seeds-5, Fennel seeds-10, Black pepper-10, Poppy seeds-2, Cinnamon-1, Cloves-1.5, Cardamom-0.5, Nutmeg-0.5, Star anise-0.1, Bay leaf-0.4, Turmeric-0.5, Red chilly-20, Mace-0.5, Dried ginger-8.0). This spice mix was stored for subsequent use.

Green Condiments: Freshly procured ginger, garlic and onion were peeled off, cut in to pieces, made in to a paste in a mixer and used as condiments in the meat ball formulation.

Other ingredients: Commercially available food grade ingredients available in the local market namely refined sunflower oil, refined wheat flour (RWF), dried spices, salt, ginger, garlic and onion were used in the present the study.

Chemicals used for analyses: Standard chemicals procured from authorized dealers were used in the present study for various analyses.

Preparation of chicken meat balls

Preparation of meat emulsion: The frozen minced meat was tempered to 4°C by keeping in refrigerator overnight and used for the preparation of emulsion. The emulsion was prepared in a bowl chopper (TC11 Bowl Cutter Scharfen, Germany) by adding minced meat and the other ingredients of the formulation (Table 1) in a sequential order at a specified time interval. During chopping, the temperature of the emulsion was maintained at 10-12°C by the addition of slush ice. GPP was added at levels of 2% (GPP2), 4% (GPP4) and 6% (GPP6) over and above the control (GPP0) formulation (Table 1) and processed as described above.

Forming, cooking and packaging of meat balls: Meat balls of 10 g weight each were formed manually and placed on stainless steel trays. Water was preheated to 50°C in a cooking vessel and the meat balls were put in to the water and cooked to reach an internal core temperature of 82°C. After cooking, the meat balls were allowed to cool at room temperature, weighed and used for analysis.

Analytical Procedures

Physico-chemical (emulsion pH, product pH, emulsion stability, product yield) and sensory evaluations were conducted for all the trials to optimize the level of inclusion of grape pomace in the chicken meat balls.

Proximate composition

Proximate composition of the cooked chicken meat balls viz., gross energy, moisture, crude protein, crude fibre, ether extract (total fat) and ash were analyzed following the standard procedure (AOAC, 1995).

Physico-chemical evaluation

***pH*:** The pH of chicken meat was determined by adopting the method of AOAC (1995).

***Emulsion stability (ES)*:** A method of Baliga and Madaiah (1971) as modified by Kondaiah *et al*., (1985) was followed for the estimation of ES. The ES calculated by the formula

Table 1: Formulation for chicken meat balls with different levels of grape pomace powder

Ingredients (g)	**Treatments**			
	GPP0	**GPP2**	**GPP4**	**GPP6**
GPP%	**0**	**2**	**4**	**6**
Lean meat	1000	1000	1000	1000
Vegetable oil	50	50	50	50
Refined wheat flour	40	40	40	40
Grape pomace powder	-	20	40	60
Salt	20	20.40	20.80	21.20
Ginger	25	25.50	26.00	26.50
Garlic	25	25.50	26.00	26.50
Onion	25	25.50	26.00	26.50
Spice mix	20	20.40	20.80	21.20
Added water	100	110	120	130

GPP0: control (without grape pomace powder),
GPP2: formulation with grape pomace powder at 2% level
GPP4: formulation with grape pomace powder at 4% level
GPP6: formulation with grape pomace powder at 6% level

$$\text{ES (\%)} = \frac{\text{Weight after heating}}{\text{Raw emulsion weight}} \times 100$$

Product yield: Weights of meat balls before and after cooking were recorded. The product yield was calculated as below

$$\text{Product yield(\%)} = \frac{\text{Weight of chicken meat balls after cooking}}{\text{Raw emulsion weight}} \times 100$$

Sensory evaluation

Semi trained sensory panel consisting of students and teaching faculty of the college evaluated the products. Samples were evaluated for appearance, flavour, juiciness, texture, tenderness and overall acceptability using an 8-point hedonic scale (Keeton, 1983) as given in the score sheet.

Texture Profile Analyses (TPA)

Texture profile analysis was performed using a texture analyzer (Stable Micro System, Model TA.XT2i/25, UK). Each sample was compressed twice to 80% of the original height (Feng *et al*., 2003) using a compression probe (P25). A cross-head speed of 10 mm/s was used. For testing, the frozen samples were heated in a microwave oven, equilibrated to room temperature for 20 mins and cut into uniformly sized cubes of 1"x 1" x 1" dimension. The values were recorded based on the software available in the instrument.

Statistical Analysis

The data generated in the present study were subjected to statistical analysis (Snedecor and Cochran, 1994) for analysis of variance, critical difference and Duncan's multiple range test was done for comparing the means to find the effect of treatment using the statistical software SPSS for windows.

RESULTS AND DISCUSSION

Proximate analyses

The moisture (%) content of all the treatments differed significantly (P<0.05) wherein the values decreased correspondingly with the increase in GPP levels (Table 2). There was a significant (P<0.05) decrease in the crude protein (%) content in GPP4 and GPP6 where that of GPP2 was comparable with GPP0. Crude fibre (%) and total ash content significantly(P<0.05) increased in GPP4 and GPP6. Addition of GPP at 4% and 6% levels to chicken meat balls showed significant(P<0.05)increase in ether extract (%) levels. There was a significant (P<0.05) increase in the gross energy level in GPP4 and GPP6 where that of GPP2 was comparable with GPP0. In accordance with this study, Ozvural and Vural (2011) observed an inverse relation between moisture and fat values in frankfurters formulated with grape seed flour. In addition, total dietary fibre of the treatments significantly increased depending on the amount of grape seed flour in the treatments and therefore they considered that frankfurters, which lack dietary fibre, could be enriched and become functional for human health. Beef sausages incorporated with grape seeds as natural antioxidants showed a decrease in protein content and increase in fat and energy content (Zahran, 2021). In a study,where wheat flour was replaced with GPP up to 10% level in the preparation of fortified breadsticks,very similar results were observed by Rainero *et al.* (2021). The replacement of wheat flour with different amounts of GPP caused a reduction in crude protein, increase in ash and increase in dietary fibre content including the insoluble fibre. Similarly, incorporation of grape skins and grape seeds in the preparation of cookies (Kuchtova *et al*., 2018) and substituting wheat flour with white grape pomace in wheat biscuits (Mildner-Szkudlarz*et al*., 2013) significantly increased the total dietary fibre content.

Physico-chemical characteristics

The emulsion pH (EpH) and product pH (PpH) significantly (P≤0.01) decreased with increase in the level of GPP (Table 3). In accordance with our results, Ozvural and and Vural (2011) also found that the pH significantly reduced with increased levels of addition of grape seed flour (GSF) (0, 0.5, 1, 2, 3, 4, and 5 per cent) in frankfurters. The drop in pH by the addition of GPP is due to the fact that it is rich in phenolic acids and tartaric acid (Nair and Pullammanappallil, 2003; Ageyeva *et al*., 2021). Sánchez-Alonso *et al.* (2007a) incorporated grape antioxidant dietary fibre prepared from red grape in minced fish at 0, 2 and 4 per cent levels and observed a reduced lipid oxidation which was attributed to the presence of antioxidant phenolic compounds in the red grape. In the present study, addition of GPP did not affect the emulsion stability and cooking yield of the chicken meat balls. Sánchez-Alonso *et al.* (2007b) found that addition of white grape dietary fibre concentrate at 2 per cent and 4 per cent to minced

Table 2: Proximate composition of chicken nuggets with/without oat flour (Mean±SE#)

	Treatments^A				Significance of treatment effect$^{\#\#}$
	GPP0	GPP2	GPP4	GPP6	
Moisture (%)	69.35^a±0.03	68.75^b±0.10	68.00^c±0.07	67.71^d±0.05	**
Crude Protein (%)	18.48^a±0.11	18.30^{ab}±0.07	18.14^{bc}±0.01	18.04^c±0.01	**
Crude Fibre (%)	0.587^b±0.015	0.597^b±0.020	0.707^a±0.032	0.780^a±0.046	**
Ether Extract (%)	3.65^b±0.43	3.83^b±0.06	4.34^{ab}±0.09	4.86^a±0.22	*
Total Ash (%)	0.95^b±0.06	1.07^b±0.08	1.68^a±0.04	1.58^a±0.05	**
Gross Energy (%)	1702^b±1	1704^b±19	1752^a±14	1793^a±16	**

Means in a row with different superscripts are significantly different
#Standard error of the mean
##Significance of treatment effect: *P <0.05, **P<0.01
A Same as Table 1

Table 3: Effect of inclusion of grape pomace powder on the physico-chemical qualities of chicken meat balls (Mean±SE#)

Quality attributes	Treatments^A				Significance of treatment effect$^{\#\#}$
	GPP0	GPP2	GPP4	GPP6	
Emulsion pH	6.09^a±0.01	6.01^b±0.01	5.90^c±0.01	5.80^d±0.01	**
Product pH	6.30^a±0.01	6.19^b±0.01	6.09^c±0.01	5.94^d±0.03	**
Emulsion stability (%)	93.64±0.30	93.89±0.24	93.58±0.22	94.15±0.05	NS
Product Yield (%)	93.22±1.32	93.52±0.73	93.43±1.20	91.84±0.84	NS

Means in a row with different superscripts are significantly different
#Standard error of the mean
##Significance of treatment effect: **P<0.01, NS - Not Significant
A Same as Table 1

Table 4: Effect of inclusion of grape pomace powder on the sensory quality of chicken meat balls (Mean±SE#)

Quality attributes	Treatments^A				Significance of treatment effect$^{\#\#}$
	GPP0	GPP2	GPP4	GPP6	
Appearance and colour score	7.00^a±0.21	6.00^b±0.37	5.33^b±0.28	4.17^c±0.44	**
Flavour score	7.00^a±0.00	6.25^b±0.13	6.00±^{b}0.21	5.00^c±0.21	**
Juiciness score	7.25^a±0.13	6.25^b±0.13	6.00^b±0.21	5.25^c±0.13	**
Texture score	7.25^a±0.13	5.75^b±0.25	5.75^b±0.25	5.00^b±0.37	**
Tenderness score	6.75^a±0.13	6.25^{ab}±0.13	5.75^b±0.25	5.00^c±0.37	**
Overall acceptability score	7.25^a±0.13	6.17^b±0.17	6.08^b±0.15	4.75^c±0.13	**

Means in a row with different superscripts are significantly different
#Standard error of the mean
##Significance of treatment effect: **P<0.01
A Same as Table 1

fish muscle of horse mackerel improved cooking yield but made the samples more softer and less springy.

Sensory characteristics

In the sensory evaluation of our study, the appearance score drastically (P≤0.05) decreased with increased levels of GPP due to its dark colour (Table 4). Also, the overall acceptability score was very low for GPP6 and that of GPP4 was organoleptically acceptable. Ozvural and Vural (2011) also observed that the overall acceptability decreased with the increased level of GSF. They stated that though the GSF was added as a fine powder as done in the present study, the particles could be perceived by the panellists, which they considered as a prejudice against products containing functional additives and might be overcome by raising consumers' awareness of their bioavailability. Sáyago-Ayerdi *et al.* (2009) incorporated grape antioxidant dietary fibre in chicken breast hamburger which significantly decreased the sensory scores, especially for the colour. Though grape pomace is known to be a good source of dietary fibre and antioxidants, studies pertaining to its inclusion in meat products is scarce. Tseng and Zhao (2013) used wine grape pomace as a source of antioxidant dietary fibre in yoghurt salad dressings and observed that the pH and sensory scores decreased with increase in grape pomace. They explained that though the grape pomace fortified products were rich in dietary fibre, in sensory evaluation they scored poor in terms of colour and overall acceptability where few panellists could feel a sour taste. In the present study also, the sensory panellists felt the taste and flavour of GPP which they disliked beyond the level of 4 per cent and this could be correlated with the significant decrease in pH. In the evaluation of incorporating grape seed flour (GSF) in cereal bars, pancakes and noodles, Rosales Soto *et al*. (2012) found that pancakes containing 25 per cent GSF and noodles containing 20 per cent GSF had low consumer acceptance and cereal bar containing 5 per cent GSF showed a good balance of high antioxidant activity with consumer acceptability.Fish muscle of horse mackerel containing 2 per cent of white grape dietary fibre was scored high in overall sensory acceptance as compared with the control (Sanchez-Alonso *et al.*, 2007b). In a study evaluating the consumers' behaviour regarding the consumption of grape pomace-based products, Baldissera *et al*. (2022) showed that informing consumers about the presence of grape pomace powder in food formulations positively impacted the product's acceptance. In wafer sheets, substitution of wheat flour with grape pomace powder at concentration of 5.00 g per 100 g was recommended by Altinok *et al*. (2022), based on the functionality, nutrient content, and sensory properties. Kuchtova *et al*. (2018) found that grape seeds and grape skins can be incorporated in cookies, without affecting their overall sensory acceptability. Incorporation of grape seed flour grape seed flour above 0.5% in frankfurter formulations significantly decreased the overall acceptability of the product (Ozvural and Vural, 2011).

Texture profile analyses

There was a significant ($P \leq 0.05$) increase in the hardness values of the GPP4 and GPP6 wherein the values of GPP2 and GPP0 were comparable (Table 5). Adhesiveness significantly ($P<0.05$) decreased in GPP4 and GPP6 whereas GPP2 and GPP0 did not differ significantly. Addition of GPP at all levels significantly ($P<0.05$) decreased the springiness, compared to control.Gumminess was significantly ($P<0.05$) highest in GPP6 where the other treatments were comparable. There were no significant differences in cohesiveness and chewiness values among all the treatments. In accordance with our study, addition of grape seed flour in summer salami (Amariei *et al*., 2018) and beef hamburger patties (Pereira *et al*., 2022), Passion fruit albedo in raw and cooked pork burgers (Lopez-Vargas *et al*., 2014) increased hardness and gumminess. Inclusion of GPP in biscuits as a substitute for wheat up to 20% significantly increased the hardness as measured by a texture analyser (Lou *et al*., 2022). In an earlier study, chicken nuggets formulated with oats powder showed an increase in the hardness and decrease in the adhesiveness, springiness and cohesiveness (Santhi and Kalaikannan, 2014). In general, addition of fruit based and other forms of dietary fibre to meat product led to an increase in the hardness probably because their addition would involve incorporating particles in the protein matrix that would strengthen the binding formed during cooking (Viuda-Martos *et al*., 2010).

CONCLUSION

Food processing industry has become well advanced with technology interventions and the products evolved according to the timely needs of the consumers. Huge research works are being carried out in the domain of functional meat products in bringing out potential healthy and convenience foods. Since meat is devoid of fibre content, enriching meat products with dietary fibre rich functional ingredients would greatly improve the nutritional value of meat. Hence incorporating grape pomace as a functional component in chicken meat balls would be highly beneficial, since grape pomace is rich in dietary fibre, antioxidants and other micronutrients. In addition, the environmental pollution caused by the disposal of grape waste from the juice and wine industries can considerably be reduced by effectively utilizing the grape pomace. From this study it can be concluded that grape pomace powder can be included in chicken meat balls at a level up to 4% without much affecting the physico-chemical and sensory characteristics.

COMPETING INTERESTS

The authors do not have any competing interests among themselves or others related to this research work.

ETHICS STATEMENT

Not applicable.

Table 5: Texture profile analyses of chicken meat balls (Mean±SE[#])

Parameters	Treatments[A]				Significance of treatment effect[##]
	GPP0	GPP2	GPP4	GPP6	
Hardness (g)	9422.88[c] ±223.84	9681.53[cb] ±229.19	10239.77[b] ±194.35	11003.70[a] ±162.80	**
Adhesiveness	-0.230[a] ±0.044	-0.432[ab] ±0.108	-0.592[bc] ±0.096	-0.801[c] ±0.109	**
Springiness (cm)	0.905[a] ±0.004	0.891[b] ±0.003	0.873[c] ±0.005	0.873[c] ±0.005	**
Cohesiveness (ratio)1	0.471 ±0.007	0.458 ±0.010	0.451 ±0.008	0.454 ±0.010	NS
Gumminess[2]	4435.29[b] ±116.72	4443.96[b] ±162.96	4610.22[b] ±90.78	4990.34[a] ±122.22	*
Chewiness[3]	4014.82 ±102.50	3962.87 ±155.06	4023.68 ±88.19	4357.34 ±118.05	NS
Resilience[4]	0.156[c] ±0.002	0.161[bc] ±0.002	0.163[b] ±0.001	0.173[a] ±0.001	**

Means in a row with different superscripts are significantly different
[#]Standard error of the mean
[##]Significance of treatment effect: *P <0.05, **P<0.01, NS - Not Significant
[A] Same as Table 1
[1]Area under second curve / Area under first curve
[2]Hardness × Cohesiveness
[3]Hardness × Cohesiveness × Springiness
[4] Area during the withdrawal of the first compression / Area of the first compression

Fig. 1. Grape pomace

Fig. 2. Grape pomace powder

ACKNOWLEDGEMENT

The authors acknowledge Tamil Nadu Veterinary and Animal Sciences University for providing the institutional support for carrying out this research work.

REFERENCES

Abdelhakam O, Elsebaie E, Ghazi A, Gouda M (2019) Quality characteristics of beef hamburger enriched with red grape pomace powder during freezing storage. Slov Vet Res 56:333-373.

Ageyeva N, Tikhonova A, Burtsev B, Globa E (2021) Physicochemical parameters of grape pomace subject to grape processing technology applied. In E3S Web of Conferences 285:05019 EDP Sciences

Altinok E, Kurultay S, Boluk E, Atik, DS, Kopuk B, Gunes R, Palabiyik I, Konar N, Toker OS (2022) Investigation of using possibility of grape pomace in wafer sheet for wheat flour substitution. Int J Food Sci Technol 57:3634–3642

Amariei S, Norocel L, Padureţ S, Gutt G (2018) Effect of grape seed flour on the quality of summer salami. J Food Process Preserv42:e13601

AOAC (1995) Official methods of Analysis. 16th Ed. Association of Official Analytical Chemist, Virginia, U.S.A.

Baldissera C, Hoppe A, Carlini NRBS, Sant'Anna V (2022) Factors influencing consumers' attitudes towards the consumption of grape pomace powder. Applied Food Research 2:100-103

Baliga BR, Madaiah N (1971) Preparation of mutton sausages. J Food Sci 36:607-610

Bekiari C, Tekos F, Skaperda Z, Argyropoulou A, Skaltsounis AL, Kouretas D, Tsingotjidou A (2022) Antioxidant and Neuroprotective Effect of a Grape Pomace Extract on Oxaliplatin-Induced Peripheral Neuropathy in Rats: Biochemical, Behavioral and Histopathological Evaluation . Antioxidants 11:1062

Bravo L, Saura-Calixto F (1998) Characterization of dietary fiber and the in vitro indigestible fraction of grape pomace. Am J Enol Vitic49:135-141

Bursa K, Kilicli M, Toker OS, Palabiyik I, Gulcu M, Yaman M, Kian-Pour N, Konar N (2021) Formulating and studying compound chocolate with adding dried grape pomace as a bulking agent. J Food Sci Tech 1-11

Cagdas E, Kumcuoglu, S (2015) Effect of grape seed powder on oxidative stability of precooked chicken nuggets during frozen storage. J Food Sci Tech 52:2918-2925

Feng J, Xiong YL, Mikel WB (2003) Textural properties of pork frankfurters containing thermally/enzymatically modified soy proteins. J Food Sci 68:1220-1224

González-Centeno MR, Rosselló C, Simal S, Garau MC, López F, Femenia A (2010) Physico-chemical properties of cell wall materials obtained from ten grape varieties and their byproducts: grape pomaces and stems. LWT Food Sci Technol 43:1580-1586

Keeton JT (1983) Effects of fat and NaCl/phosphate levels on the chemical and sensory properties of pork patties. J Food Sci 48:878-881

Kondaiah N, Anjaneyulu ASR, Rao VK, Sharma N, Joshi HB (1985) Effect of salt and phosphate on the quality of buffalo and goat meats. Meat Sci15:183-192

Kuchtova V, Kohajdova Z, Karovicova J, Laukova M (2018) Physical, textural and sensory properties of cookies incorporated with grape skin and seed preparations. Polish J Food Nutr Sci 68:309–317

Lopez-Vargas JH, Fernandez-Lopez J, Perez-Alvarez JA, Viuda-Martos M (2014) Quality characteristics of pork burger added with albedo-fiber powder obtained from yellow passion fruit (*Passiflora edulis var. flavicarpa*) co-products. Meat Sci 97:270-276

Lou W, Zhou H, Li B, Nataliya G (2021) Rheological, pasting and sensory properties of biscuits supplemented with grape pomace powder. Food Sci Technol 42:e78421

Mildner-Szkudlarz S, Bajerska J, Zawirska-Wojtasiak R, Górecka D (2013) White grape pomace as a source of dietary fibre and polyphenols and its effect on physical and nutraceutical characteristics of wheat biscuits. J Sci Food Agric 93:389-395

Mostafa A, Nassar AG, El-Badry N, Ammar MS (2022) The physicochemical and functional properties of red grape and peanut skin powders. Arch Agri Sci J 5:88-103

Nair S, Pullammanappallil P (2003) Value added products from vineyard wastes-a review. Proceedings of ORBIT108-118

Ozvural EB, Vural, H (2011) Grape seed flour is a viable ingredient to improve the nutritional profile and reduce lipid oxidation of frankfurters. Meat Sci88:179-183

Pereira A, Lee HC, Lammert Jr R, Wolberg Jr C, Ma D, Immoos C, Casassa F, Kang I (2022) Effects of red-wine grape pomace on the quality and sensory attributes of beef hamburger patty. Int J Food Sci Technol 57:1814-1823

Rainero G, Bianchi F, Rizzi C, Cervini M, Giuberti G, Simonato B (2022) Breadstick fortification with red grape pomace: Effect on nutritional, technological and sensory properties. J Sci Food Agric 102:2545-2552

Rosales Soto MU, Brown K, Ross CF (2012) Antioxidant activity and consumer acceptance of grape seed flour-containing food products. Int J Food Sci Technol 47:592-602

Sanchez-Alonso I, Jimenez-Escrig A, Saura-Calixto F, Borderias AJ (2007a) Effect of grape antioxidant dietary fibre on the prevention of lipid oxidation in minced fish: evaluation by different methodologies. Food Chem101:372-378.

Sanchez-Alonso I, Solas MT, Borderias AJ (2007b) Physical Study of Minced Fish Muscle with a White-Grape By-Product Added as an Ingredient. J Food Sci 72:E94-E101.

Santhi D, Kalaikannan A (2014) The effect of the addition of oat flour in low-fat chicken nuggets. J Nutr Food Sci 4:1

Santhi D, Kalaikannan A, Natarajan A (2020) Characteristics and composition of emulsion-based functional low-fat chicken meat balls fortified with dietary fiber sources. J Food Process Eng 43(3), e13333.

Santhi D, Kalaikannan A, Elango A, Natarajan A (2022) Functional Chicken Meatballs with Carrot Pomace Powder. J Meat sci 17: 31-36.

Sayago-Ayerdi SG, Brenes A, Goni I (2009) Effect of grape antioxidant dietary fiber on the lipid oxidation of raw and cooked chicken hamburgers. LWT Food Sci Technol 42:971-976

Snedecor GW, Cochran WG (1994) Statistical Methods 1st Edn. The Iowa State University Press, Iowa, USA

Statista Research Department (2022) Consumption of poultry meat in India 2013-2021 https://www.statista.com/statistics/826711/india-poultry-meat-consumption/#statisticContainer Accessed 04 July 2022

The Economic Times (2022) Chicken consumption sees an uptick https://economictimes.indiatimes.com/news/economy/indicators/chicken-consumption-sees-an-uptick/articleshow/89001076.cmsAccessed 04 July 2022

Tseng A, Zhao Y (2013) Wine grape pomace as antioxidant dietary fibre for enhancing nutritional value and improving storability of yogurt and salad dressing. Food Chem 138:356-365

Viuda-Martos M, Ruiz-Navajas Y, Fernandez-Lopez J, Perez-Alvarez JA (2010) Effect of orange dietary fibre, oregano essential oil and packaging conditions on shelf-life of bologna sausages. Food Control 21:436-443

Yavruyan NV, Avetisyan NA (2021) Food Powder Manufacture from Grape Pomace and its Application as an Improver in the Macaroni Production. Agriscience and Technology 4:428-431

Zahran REBA (2021) Quality of Sausage Prepared with Grape seeds as Natural Antioxidants. Egypt Journal for Specialized Studies 9:5-19