Table S1: Summary of Studies on the Use of Fruit Pomace (Apple and Grape) in Meat Products: By-products, Treatments, Analyses, and Sensory Outcomes

Author	By-product	Form of the by-Fproduct	Groups of meat products	List of analysis	Physiochemical results	How was sensory analysis conducted	Sensory analysis results
Carpes, 2020	Grape pomace	Grape pomace (stem, seed, skin, pulp) was dried at 35 °C for 2 days, milled, and stored at –12 °C. It was ethanol-extracted, freeze-dried, mixed with maltodextrin, and spray-dried into microparticles.	T1 was the negative control with nothing added to the base pate formulation. T2 was the positive control with sodium erythrobate. T3 was the freeze dried grape pomace added to the original recipe T4 had the microencapsulated form of the pomace added.	Lipid oxidation evaluation	TBARS was used to assess lipid peroxidation. T3 showed the lowest levels throughout storage, except on day 35. Both T3 and T4 had lower values than the positive control.	N/A	N/A
Carrapiso, 2024	White grape pomace	White grape pomace (destemmed) from a winery was blanched, treated with high hydrostatic pressure, and processed into a powder.	There were 4 groups made with the sausage. Group 1 was the control plain formulation Group 2 NITRASC is the positive control with sodium nitrate. Group 3 0.5% pomace was weight in weight Group 4 3% Pomace weight in weight	Lipid oxidation evaluation Protein oxidation Microbial counts Polyphenol measurements Color Physiochemical analysis	Water activity, pH (3% GP), and moisture content decreased significantly with GP addition. Phenol content was higher in the control and 0.5% GP. The positive control (sodium nitrate) reduced mesophilic, psychrotrophic, and LAB counts—though lower LAB counts are not always beneficial. GP showed potential to reduce lipid oxidation, but no significant differences were found between the positive control and pomace groups. GP did not improve instrumental colour over the positive control.	12 Trained panellists were used for a descriptive taste test	The positive control scored highest for lean color and juiciness, and lowest for fat color and off-odor intensity, indicating beneficial effects on dry-cured meat quality. The control group and 0.5% grape pomace (GP) treatment had similar sensory scores. Only the 3% GP inclusion negatively affected texture, leading to defective texture ratings.

Choi, 2016	Apple pomace fiber	Apple pomace from juicing was washed, air-dried, treated with Termamyl to remove starch, ethanol-washed, dried again, cooled, and vacuum-sealed.	Chicken breast meat- CBM, Pork back fat- PBF, Ice water- IW, Apple pomace fiber- APF. CONTROL = 50%- CBM, 30%-PBF, 20%- IW. T1 = 50%- CBM, 25%- PBF,25%- IW. T2 = 50%- CBM, 25%- PBF, 24% -IW, 1% APF. T3= 50%- CBM, 25%- PBF, 23% -IW, 2% APF T4 = 50%- CBM, 20%- PBF, 30% -IW T5 = 50%- CBM, 20%- PBF, 29% -IW, APF- 1% T6= 50%- CBM, 20%- PBF, 28% -IW, 2% APF.	Proximate analysis Caloric content Cooking loss pH color measurements TPA emulsion stability	Treated sausages had higher moisture content than controls, while protein content showed no significant changes. Fat content was highest in control sausages. Fiber inclusion reduced caloric content and cooking loss. Apple pomace fiber increased yellowness, decreased redness, and raised hardness, cohesiveness, and gumminess.	N/A	N/A
Chilli, 2019	Grape pomace flour	Frozen grape juice leftovers (skin and seeds) were air-dried at 40 °C for 72 hours, milled to 0.25 mm, irradiated, then frozen and stored in foil-wrapped amber jars to prevent light degradation.	There were 4 groups made out of the base burger recipe Control had nothing added BHT group had synthetic antioxidants added GPF 1% Had 1% added GPF 2% had 2% added	Proximate analysis instrumental color Lipid oxidation Microbiological analysis	No significant differences in protein between controls and treatments. Dietary fiber increased with higher GP concentrations. GP darkened samples progressively and delayed TBARS increase during frozen storage, matching the effectiveness of synthetic antioxidants.	110 consumers that were untrained. 10g of sample from each group based on a 9 point hedonic scale for color, odor taste texture appearance and overall quality.	The treated burgers showed significantly lower scores for liking, appearance, color, and overall quality. However, the grape pomace (GP) flour samples effectively masked the fish flavor. No significant differences were observed in odor scores between treatments.

Egea, 2020	grape skin (Inulin and beta glucan)	No information provided on the source or preparation of the grape extract.	Three groups were created for two different types of sausage Group 1 had a base recipe of 25% fat for frankfurter and 30% fat for the spainish sausage with the rest made up by lean ham Group 2 for the frankfurter fat was reduced to 12.5% and 6% inulin, with 0.5% beta glucan, The spainish sausage was 20% fat with 3% inulin, 0.5% Beta glucan. Group 3 was for the frankfurter 3% inulin, 1% beta glucan, 0.5% GPE. The spainish sausage was 6% inulin, 1% Beta glucan and 0.5% GPE.	Instrumental color covered TPA	Both sausage types showed reduced lightness with fiber addition, likely due to fat reduction. No significant differences were found between control and fiber-added frankfurters. Spanish sausages showed significant changes in chewiness, extensibility, and cohesiveness, with decreases in hardness and gumminess after grape pomace addition. Differences may be due to smaller meat batter size in frankfurters.	8 assessors were trained on how to analyse meat. A quatitative descriptive analysis was used as a scale. Each participant tasted three samples per treatment and replicate. Areas assessed were the color, intensity of different odors, taste, flavors. overall rating was also assessed.	Color changes were noted by assessors only in sausages with added grape extract. Odor scores decreased as fiber content increased. Texture remained largely unchanged, except in frankfurters with grape pomace, which showed increased hardness and chewiness. The treatment groups also reduced boar taint in both odor and flavor.
Garrido, 2011	red grape pomace	Industrial grape pomace was extracted using two methods: (1) high–low instantaneous pressure followed by methanolic extraction, and (2) methanolic extraction only.	120 burgers were split into three groups. Control had no extracts, and the other two groups had the two different type extracts GP1 nad GP2 added as 0.06g/100g of meat.	Raw samples had pH, color, microbiological analysis, TBARS test,	No significant pH differences between storage times or treatments. Spoilage was unaffected by either grape pomace extract. GP1 (pressure-extracted) most effectively reduced lipid oxidation after 3 days. GP1 patties were darker than controls, likely due to natural colorants; redness decreased over time in all	N/A	N/A

					groups. GP1 burgers showed lower yellowness scores.		
Grispoldi, 2022	Apple pomace	Apple pomace was prepared using a domestic juicer, dried at 55 °C until constant weight, milled with a blender, and stored in amber glass at room temperature.	There were three groups that were used with a control as a standard and then there was 7% added apple pomace group and a 14% addition group. Sampling was done at day 0 of ripening and days, 5,11,19, 25	There was pH, water activity and hardness analysed Color analysed using an app and CIELAB. Microbiological analysis of 8 bacterial populations.	pH decreased over 5 days of ripening; apple pomace (AP) had no significant effect. Water activity slightly decreased with higher AP levels after day 5. Hardness was not correlated with AP, but 14% AP salami was harder than 7% and control. Redness was higher in controls except at T19; redness was similar at T25 between control and 7% AP. Fat, energy, and protein decreased with AP, while ash, carbohydrates, moisture, total polyphenols, and antioxidant capacity (ABTS, DPPH, FRAP) increased. Fermentation-related bacteria were higher with AP; spoilage bacteria levels remained comparable, indicating similar safety and hygiene.	Panel of 16 trained assessors with a seven point scale for characteristics that were measured.	The control salami scored highest for color intensity, uniformity, and fat-lean distribution, followed by 7% and then 14% apple pomace (AP) inclusion. Odor and moldy odor scores were similar across all groups. Flavor intensity, salty, acidic, moldy, and spicy flavors showed no significant differences, but the AP salamis had higher rancid and bitter flavor scores. Texture-wise, the 14% AP salami had lower juiciness and chewiness but higher hardness. Overall acceptability ranked highest for the control, then 7% AP, and lowest for 14% AP salami.

Kumar, 2024	Apple pomace powder	No source information provided. Apple pomace was dried at 60 °C and stored at –18 °C.	The control had a mixture of multiple ingredients and then groups T4, T5, T6 had 2%, 4% and 6% inclusion of the apple pomace powder respectively.	Ph, emulsion activity, water holding capacity as well as cooking yield. Proximate composition Salt soluble proteins TPC Color analysis Texture analysis	pH decreased with apple pomace powder (APP) addition. Water holding capacity and emulsion stability improved significantly in APP treatments, reflected in better cooking yields. Moisture content was lower than control; protein and fat remained unchanged. Ash content was higher in the 6% APP batch (T6), and crude fiber improved significantly. Salt-soluble proteins were lower in T5 and T6. Total phenolic content (TPC) increased with APP, highest in T6. Lightness decreased, redness and yellowness (b) increased in T6. Hardness rose with higher APP (T5 and T6), while springiness and cohesiveness decreased in T6 compared to control.	Experienced assessors used 8 points scales on basic sensory attributes	All apple pomace (AP) meat inclusion batches scored above 7 out of 8 for flavor. However, the 6% AP meat emulsion had significantly lower texture scores and overall acceptability compared to the control batches.

Palanisamy, 2022	Apple pomace	No details provided on the source or form of apple pomace used.	There were three different meat blocks and 6 treatment runs per block so 18 treatment runs all together. The most inclusion was 1% and this was split between one two or three inclusions of either Sodium Triphosphate, apple pomace or coffee silver skin.	Water holding capacity and cook loss lipid oxidation Texture analysis color measurement Nuclear magnetic resonance compositional analysis	Phosphorus increase raised ash content as expected. Fiber content increased with apple pomace (AP) addition. Water holding capacity (WHC) was highest with STPP above 0.5%, indicating good interaction with fiber. Lower STPP levels led to higher cooking loss. AP addition increased water bound to proteins. AP combined with STPP raised lightness scores and lowered redness, with minimal differences between trials. AP affected hardness, chewiness, gumminess, and springiness compared to the STPP control. Lipid oxidation slightly increased with AP addition.	N/A	N/A
Pollini, 2022	Apple pomace	Apple pomace was prepared by the authors as fresh and freeze-dried forms, milled to a fine powder. Ultrasound-assisted extraction was applied, but only freeze-dried pomace was used to fortify the beef burgers.	The groups of burgers had 0%, 4%, and 8% apple pomace included.	pH and water activity color analysis microbiological analysis	No significant pH differences between storage and treatment groups. Water activity decreased over time in AP-fortified burgers. After 96 hours, AP-fortified burgers showed lower lightness (L) and redness scores compared to controls. Lactic acid bacteria counts were higher in AP burgers, while coliform levels were lower.	Triangle test was completed with 20 previously trained assessors. The same 20 assessors were asked about sensory attributes of the three burgers.	The triangle test indicated perceptible differences in texture and flavor among all groups. Color uniformity was better in the control, while color intensity was highest in the 8% AP burger. The 8% AP burger scored higher for acidic and sweet flavors but lower for elasticity and cohesiveness. Additionally, fattiness and juiciness were reduced in the 8% inclusion, which also had lower overall acceptability compared to the other two groups.

Riazi, 2016	Grape Pomace	Grape juice by-products (skin, seeds, stems) were dried at 55 °C for 12 hours, milled into a powder, irradiated, and stored in bags at 4 °C.	Control with beef sausage formulation and sodium nitrate 120mg/kg T1 had 60mg/kg of sodium nitrate and then 1% grape pomace T2 had 30mg/kg sodium nitrate and then 1% grape pomace T3 had 60mg/kg sodium nitrate and 2% grape pomace T4 had 30mg/kg sodium nitrate and 2% grape pomace	color measurements lipid oxidation antioxidant activity Total phenol content microbiological analysis	Increased grape pomace addition darkened the sausages. T2 and T4, with less sodium nitrate, showed lower color intensity. The 2% grape pomace samples had significantly different overall color compared to 1% samples. No significant differences in TBARS lipid oxidation between batches, though grape pomace reduced oxidation during storage. Total phenolic content (TPC) showed no significant differences with pomace addition, but blanks and controls differed positively. Antioxidant activity was highest in T3 and T4 during the first 10 days, declining over the next 20 days. Microbial growth was reduced in higher sodium nitrate groups; grape pomace effects were similar to controls and lower than blanks.	2 sessions of 20 trained assessors with 5 point hedonic scales with properties assessed by appearance, color odor taste, texture and overall acceptability	In this case, grape pomace enhanced the flavor profile and improved the texture of the beef sausages. However, overall acceptability was negatively affected when grape pomace exceeded 1%.

Solari-Godino, 2017	Grape pomace	Grape pomace from the Pisco process was dried at 18–30 °C for 36 hours, milled, and treated with ethanol and water to remove sugars. The residue was then cool-dried again.	The groups were split as 0, 2, 3, and 4% w/w.	Polyphenol determination Antioxidant capacity measurements WHC Cooking loss shear strength TPA Color Bioavailability	The 3% grape pomace inclusion had the highest polyphenol levels among groups, with significant increases in FRAP and ABTS antioxidant measures compared to control. Water holding capacity improved with higher dietary fiber in raw samples, and fiber-added samples showed reduced cooking loss. Shear strength increased with grape pomace in both raw and cooked samples. Texture Profile Analysis (TPA) indicated that grape pomace above 2% significantly affected hardness, springiness, and chewiness in raw and cooked samples. Lightness decreased significantly at 3% and 4% inclusion, while redness and yellowness remained unchanged. In vitro tests showed increased bioavailability with higher grape pomace addition.	10 Trained panellists assessed the general acceptance of the samples. The anchovy mince was cut into 1cm thick pieces and grilled. The characteristics were measured on a 10 point hedonic scale.	No changes in color or off-flavors were detected in any of the fortified samples. The control had the lowest overall acceptability score compared to the fortified groups.

Thankgavelu, 2022	Ultrasound-treated Apple pomace	Apple pomace from a Spanish company was oven-dried to constant weight, powdered, rehydrated, treated with ultrasound, freeze-dried, and stored at 4 °C.	The main comparison is between US and non US treated samples. Formulation 1: 0.2% STPP+ 0.22% AP + 0.58% CSS Formulation 2: 0.2% STPP + 0.00% AP + 0.80% CSS Formulation 3: 0.06% STPP + 0.94% AP + 0.0% CSS	WHC Cooking loss Emulsion stability Proximate content lipid oxidation color textural parameters	No significant differences in proximate composition between treated and untreated samples. Emulsion stability, measured by total expressible fluid (TEF), improved with ultrasound (US) processing; formulations 1 and 3 showed reduced TEF, indicating increased water and oil absorption capacity. Water holding capacity (WHC) increased when apple pomace (AP) was removed from US-treated formulations and decreased when AP was reintroduced in formulation 3. Water mobility improved in formulations 1 and 2 despite reduced phosphate levels. WHC was lowest in non-US-treated formulations with the highest AP content. Cook loss was lower in US-treated sausages. US treatment minimized color changes; formulation 2 without AP had increased redness. No significant texture differences were observed, although AP and CSS reduced hardness and chewiness. Lipid oxidation remained similar across formulations until day 9, when formulation 3 showed higher TBARS in US-treated samples.	N/A	N/A

Tournour, 2017	Grape extract	Skin and seeds were oven-dried, ground, and extracted.	There were 10 different formulations designed. 0 g/100 g, 120mg/kg 15 g/100 g, 60mg/kg 4 g/100 g, 162mg/kg 26 g/100 g, 78mg/kg 4 g/100 g, 78mg/kg 15 g/100 g, 120 mg/kg 26 g/100 g, 162 mg/kg 30 g/100 g, 120 mg/kg 15 g/100 g, 180 mg/kg 15 g/100 g, 120 mg/kg	Color	Color was influenced by the interaction between mechanically deboned meat (MDM) and grape pomace extract (GPE); whiteness decreased as both increased. Redness was unaffected by GPE at low MDM levels. The b* (yellowness) value decreased with grape pomace addition.	79 untrained assessors were used. Acceptance was assessed on a nine point scale.	The formulation with 15g MDM and 60mg AP received the highest ratings, representing the lowest amount of grape pomace extract (GPE) among the groups. Higher inclusions of MDM and GPE resulted in nuggets that were described as dark and off-colored.
Younis, 2018	Apple pomace powder	The only detail provided is that the apple pomace was ground.	Meat was replaced in 0,2,,4,6,8%.	Physiochemical Textural analysis color analysis	Fat content increased with apple pomace (AP) incorporation, while pH decreased as AP levels rose. Moisture and fiber content significantly increased in AP-enriched patties. Water activity and water holding capacity also improved, alongside enhanced cooking yield and emulsion stability. Textural properties—firmness, toughness, hardness, gumminess, and chewiness—increased significantly with higher AP inclusion. Color-wise, AP reduced lightness and yellowness but increased redness in the patties.	Conducted with 5 trained panellists with a 9 point hedonic scale.	An 8% incorporation level of apple pomace negatively affected the color of the patties. Significant differences in flavor acceptance were observed between the 6% and 8% apple pomace patties compared to the control. The sweetness imparted by the apple pomace was disliked by the panelists. Juiciness scores increased with higher apple pomace inclusion. Overall acceptance was highest for the 6% apple pomace patties, with acceptance declining beyond this level.