

December 2001

Weeks Publishing Company

Food Product

D E S I G N

A Supplement to Food Product Design

***Dried Plums
Solve
Meat-y Issues***





Dried Plums Solve Meat-y Issues

By Heidi Kreuzer
Contributing Editor

Designers of meat and poultry products are faced with a multitude of conflicting problems and issues. How can you ensure safety from the various pathogens that all too often impact public health and rock consumer confidence? Likewise, how can you also achieve sufficient moisture to ensure consumer taste and texture satisfaction, particularly if ultra-lean meats are utilized or if meats are pre-cooked? Finally, if meats are pre-cooked or part of a prepared entrée, how can you ensure off-flavors don't negatively affect sensory characteristics?

Plums provide the solution

Imagine that an all-natural, fruit-based ingredient could help avoid these food development pitfalls and preserve the hallmarks of good-quality meat: safety, flavor and moisture. Luckily, such an ingredient already exists, in the form of dried plums. You might think you already know all there is to know about dried plums, but take note. **Food Product Design** revisited researchers at Texas A&M University and Kansas State University (see the magazine's February 2001 supplement, "Research Reveals the Power of Dried Plums in Precooked Meats," available online at www.CaliforniaDriedPlums.org), to discover that additional study results have added fresh

support to the investigators' initial conclusion that dried plum ingredients impart a bevy of benefits and functionalities to meat products. The top three:

- Fighting microbes
- Retaining moisture
- Preventing warmed-over flavor (WOF).

And, not only do dried plum ingredients help prevent WOF, they yield a pleasing flavor profile simply by being present in meat. This is particularly true for low-fat meat products, which benefit from dried plums' moisture-retaining fiber and sorbitol and flavor-potentiating malic acid. Malic acid, in fact, is thought to impart a fat-mimicking mouthfeel that humans instinctively appreciate. Not bad for a "dried-up" fruit —

especially considering that dried plum ingredients typically deliver all these benefits at an average by-weight usage rate of 3%.

Fighting meat pathogens with plums

To discover more about the power of dried plums, let's first pay a return visit to Kansas State University in Manhattan, where seasoned meat-pathogen researcher Daniel Y.C. Fung, Ph.D., and colleagues are gauging the ability of dried plum ingredients to inhibit meat microorganisms.

When we last checked in with the Kansas State research crew, Fung and graduate student Leslie Thompson had completed an initial series of tests to determine the effects of plum ingredients on *Salmonella typhimurium*,

Escherichia coli 0157:H7, *Listeria monocytogenes*, *Yersinia enterocolitica* and *Staphylococcus aureus*. According to data from that portion of their research, at a 3% usage rate, both dried plum puree and fresh plum juice effectively suppress pathogens.

In a follow-up study, Thompson obtained three discrete types of dried plum ingredients from the Sacramento, CA-based California Dried Plum Board (CDPB): dried plum puree; fresh plum juice concentrate; and a powder consisting of a mixture of dried plums and pears. She formulated five pork sausage (about 34% fat) mixtures with various levels of antioxidants – namely, 0.02% BHA/BHT, 3% dried plum powder, 6% dried plum powder, 3% dried plum puree and 6% dried plum

puree – along with a control containing no antioxidant. In ground beef (20% fat), Thompson tested 3% dried plum puree and 3% plum juice concentrate, along with a control.

All tests were run for five days, with samples taken on days 0, 1, 3 and 5. After day five in uncooked ground beef, Thompson observed a 1 to 2 log cfu (colony-forming units)/gram greater rate of suppression (i.e., fewer of all five types of microorganisms tested) as compared to the control (see table) for both dried plum puree and plum juice. After day five in uncooked pork sausage, significant suppression of *E. coli* 0157:H7 and *Y. enterocolitica* was observed with 6% dried plum puree and 6% dried plum powder.

Independent Cook-Up Proves Plums Taste Great in Burgers

When the *San Francisco Chronicle* ran an article last 4th of July detailing Daniel Y.C. Fung, Ph.D.'s, antimicrobial research at Kansas State University in Manhattan, the curious newspaper staff decided to put Fung's pathogen-fighting, dried-plum strategy to a taste test. The reporters cooked up beef and turkey burgers containing dried plums, noting that although they used dried-plum baby food as their ingredient source, another option is using 1 tablespoon of dried plum puree per pound of ground meat. (The latter, in fact, is Fung's official recommendation.)

The results of this burger cook-up? "One tester," reports the *Chronicle*, "said the puree worked so well she actually enjoyed eating a well-done burger." In addition, the dried plums enhanced the beefy taste in the ground-beef burgers, while making all burgers, particularly lean meat and turkey varieties, moister and juicier.

The burger cook-up was successful on another flavor front as well – the next day, says the report, "both refrigerated, prune-enhanced beef and turkey burgers tasted much fresher than their non-prune compatriots." So, not only can dried plums help stop *E. coli*, *Salmonella*, *Listeria* and other organisms in their tracks, they can simultaneously create a tastier, more flavorful product. ■



Overall, Thompson reports: “dried plum mixtures can control foodborne pathogens in uncooked meat products. All inoculated pathogens in ground beef decreased by 1 to 2 log cfu/gram and decreased in total aerobic count, *E. coli* O157:H7, *L. monocytogenes*, *Y. enterocolitica*, and *S. aureus* of at least 0.5 log cfu/gram in uncooked pork sausage.”

Additionally, notes Thompson, dried plum mixtures can help prevent any recontamination that might occur after meat processing. In cooked pork sausage, she recorded a 0.5 log cfu/gram suppression of total bacterial count with 3% dried plum puree and significant suppression of *E. coli* O157:H7 and *Y. enterocolitica* with 3% and 6% dried plum puree.

Dried plums’ impressive pathogen-fighting powers are not going unnoticed, even outside food-science circles. For example, *Parade Magazine* recently devoted an entire issue to food news, citing professor Fung and his research at Kansas State University in an article entitled “The Year’s Best Food News.” The piece dispenses Fung’s advice for fighting microbes on a consumer level, advising home cooks to mix one tablespoon of dried plum puree (1.3 cups, or 8 oz., of dried plums blended with 6 tablespoons of hot water) in a pound of meat before refrigeration to suppress pathogens such as *E. coli*.

Improving meat flavor with plums

Next up on our dried plum research tour is College Station, TX, where professor and veteran researcher Jimmy T. Keeton, Ph.D., and his team of researchers in Texas A&M University’s department of animal science (meat science section) have spent a considerable amount of time investigating



the antioxidant properties of dried plum ingredients. Keeton and his crew, which includes Ki Soon Rhee, Ph.D., and Ph.D.s-to-be Randi Boleman and Maryuri Nuñez, hypothesize that plums’ phenolic chlorogenic and neochlorogenic acids hinder free-radical-induced fatty-acid oxidation. This very oxidation is the culprit for the rancid, cardboard-like flavors — generally described as warmed-over flavor, or WOF — that are so unwelcome in meats, and which are particularly prevalent in precooked meats.

At the time of our last visit, the A&M team members were wrapping up the first step of a study investigating dried plum puree’s antioxidant ability in pork sausage, as determined by the 2-thiobarbituric acid test, which measures malonaldehyde content, and thus, by extension, lipid oxidation. (Malonaldehyde is a breakdown product of lipid oxidation, so a higher malonaldehyde content indicates a higher rate of oxidation, and in turn, more WOF.) “We found that at 3%, dried plum puree is an effective antioxidant in preventing oxidative rancidity — as effective as a combination of BHA (butylated hydroxyanisole) and BHT

(butylated hydroxytoluene), which are standard chemical antioxidants used at 0.02%,” says Keeton. “This was true for both refrigerated and frozen precooked pork sausage.”

Evaluating meat/plum flavors

In the next step of its investigation, the A&M team performed extensive sensory panel evaluations to determine the acceptability and level of WOF in precooked pork sausage with various levels of dried plum ingredients. Six antioxidant treatments were evaluated: 3% dried plum puree; 6% dried plum puree; 3% dried plum and apple puree; 6% dried plum and apple puree; 0.02% BHA/BHT; and a control (no antioxidant). Refrigerated samples were evaluated on day 0, 7, 14 and 21 of the investigation, and frozen samples were evaluated on days 30, 60 and 90.

For the sensory evaluation step, as for the previous portion of the investigation, pork sausage was chosen because of its high potential for oxidative rancidity stemming from its high fat content — specifically, higher

amounts of polyunsaturated fatty acids as compared to ground beef, for example. (The more unsaturated a fat, the more susceptible it is to oxidation.)

At the university's Sensory Testing Facility, a panel was trained to characterize cooked pork sausage samples for flavor (cooked pork/brothy, cooked pork fat, spicy/peppery, soured, cardboard, painty, fishy, prune/plum, sage, brown/burnt and vinegar); basic tastes (salt, sour, bitter and sweet); feeling factors (metallic and astringent); mouth-feel (pepper burn); aftertastes (sage, pepper, salt, sweet, prune and sour); and texture (juiciness, denseness, fracturability, springiness, hardness and cohesiveness). Attributes were rated on a 16-point scale where 0 indicated absence of an attribute and 15 indicated extremely intense presence of an attribute. "Basically," explains Keeton, "we used the trained sensory panel as

an instrument to find degrees of difference in taste, flavor and texture."

Across all the treatments, cooked pork/brothy, cooked pork fat, spicy/peppery, prune/plum and sage were the five flavors for which degrees of difference were recorded. Panelists attached the highest scores for cooked pork/brothy, cooked pork fat, spicy/peppery and sage flavors to the control and BHA/BHT-treated samples — the higher the level of dried plum puree, the lower the intensity of these flavors. "Dried plum puree made it a milder product," says Keeton. "It also increased sweetness and decreased the bitter and salty tastes."

Not surprisingly, prune/plum flavor was strongest in the samples containing dried plum puree, while salt and bitter tastes were the highest in the control and BHA/BHT samples. The control and BHA/BHT samples

also had a more pronounced pepper burn than the samples containing dried plum puree and dried plum and apple puree. As for springiness, this attribute declined somewhat in samples containing dried plum ingredients, perhaps because of the accompanying slightly reduced-fat content of these samples.

For all samples, the panel detected no differences in juiciness, denseness, fracturability and cohesiveness. Chemical composition tests revealed, however, that all samples had a higher moisture content and lower fat content due to dilution of the meat block. Samples with dried plum and apple puree contained the most moisture, at about 53%, compared to about 52% for the BHA/BHT samples and approximately 51% for the samples containing dried plum puree. Protein percentage was not affected by the antioxidant treatments. Cook yields ranged between 79% and 82%. Researchers theorize that this relatively large yield range is due to the inherently variable cooking loss rate for the patties, observing that "dried plum puree ingredients serve as natural humectants and likely aid in juice retention of pork sausage formulations, even with 3% to 6% dilutions in the total meat block."

Evaluating meat/plum colors

Moving on to color, the A&M researchers used lab (L^* , a^* , b^*) color space values to measure both external and internal color changes. Surface L^* (lightness) values were slightly lower (darker) for 6% dried plum puree, 3% dried plum puree and 6% dried plum and apple puree than for the control sample. However, samples with 3% dried plum and apple puree had the same surface L^* values as the control and the BHA/BHT samples, although it should be noted that even the 6%



dried plum puree sample, which had the darkest surface color, was not objectionably dark. Surface a^* values (redness) did not change for any of the treatments, while surface b^* values (yellowness) were slightly higher in both the 3% and 6% dried plum-puree samples as compared to the control. BHA/BHT product also had higher (more yellow) value.

The samples' internal L^* values were consistent with the L^* external values, with slightly lower numbers for the 3% and 6% dried plum puree and 6% dried plum and apple puree specimens. Internal a^* values declined a bit for 3% and 6% dried plum puree samples, while 6% dried plum and apple and BHA/BHT did not affect internal redness. For all treatments, internal b^* values were higher than for the control.

Consumers give plums thumbs-up

Texas A&M's trained panel sensory results help illuminate how dried plum ingredients affect pork sausage, and by extrapolation, how they're likely to affect other meats. But perhaps the most encouraging news for meat-product manufacturers comes from a further evaluation step taken by the A&M investigators — gathering input from “average citizens.” In addition to the trained panel, researchers also fed pork-sausage samples to a 118-member consumer panel. Analysis of this panel's responses indicates that “the patties containing dried plum puree and dried plum puree blend were as acceptable as the control,” says Keeton.

Specifically, samples with 3% dried plum puree and 3% dried plums and apples puree tested on par with the control and BHA/BHT-treated samples for flavor, indicating that even the most finicky consumers are likely to happily

consume products with this level of dried plums. Potential applications include almost any type of meat and poultry product, such as meat balls and meat fillings, pizza toppings, pre-cooked meat patties, fresh sausages, frankfurters, brown-and-serve sausages, turkey and chicken patties and various poultry sausages, to name a few.

In terms of applicability and usage rate, 3% appears to be the optimum level all around — in ground beef for example, it has been shown that optimum moisture binding occurs at this level. In addition, as Keeton et al.'s series of studies has shown, dried plum puree functions effectively as an antioxidant at 3%, proving that, when it comes to dried plums, as with so many other things in life, a little of a good thing goes a long way.



Dried Plum Facts and Figures

- Per 100 grams of product, dried plums have a high ORAC (Oxygen Radical Absorbance Capacity) value, which indicates how well a compound is able to “quench” free radical reactions. At 5,770, dried plums have the highest score (among the most commonly eaten fruits and vegetables), while at 949, fresh plums also score well. According to the USDA, Tufts University, other fruit and vegetable scores include: raisins, 2,830; blueberries, 2,400; kale, 1,770; strawberries, 1,540; spinach, 1,260; beets, 840; cherries, 670; and eggplant, 390.
- Dried plums contain a high percentage of sorbitol and fiber, which are natural humectants, and malic acid, which is a flavor potentiator.
- Most U.S. plums are grown in California, and dried plum ingredients are produced from the La Petite D’Agen variety, which has a high-enough sugar content to allow the fruit to dry without fermenting. On average, 200,000 tons of dried plums are produced every year. ■

The next steps

Both Texas A&M and Kansas State are presenting their dried plum ingredient data at various seminars and conferences, and Keeton et al.'s work is slated to appear in the *Journal of Food Science*. The next portion of Texas A&M's research will center on beef roast (10% brine pump) and cured ham (15% brine pump). “We’re injecting dried plum juice concentrate as well as fresh juice concentrate into pre-cooked roast beef and ham,” says Keeton, “and we’re also evaluating a spray-dried (dried plum) material that we incorporated into the brine.”

In addition, Keeton is planning to investigate how dried plums can work in tandem with irradiation, a process which used alone as an antimicrobial treatment can cause discoloration and

Plums Fight Pathogens in Uncooked Ground Beef

The following table reports the inhibitory effects of dried plum puree and fresh plum juice as tested on five pathogens in fresh ground beef.

Treatment	Day	Total Count (log cfu/g*)	<i>S. typhimurium</i> (log cfu/g)	<i>E. coli</i> O157:H7 (log cfu/g)	<i>L. monocytogenes</i> (log cfu/g)	<i>Y. enterocolitica</i> (log cfu/g)	<i>S. aureus</i> (log cfu/g)
Control	0	5.06 ^a	4.30 ^{ab}	4.25 ^a	3.80 ^{ab}	3.92 ^a	3.69 ^a
	1	6.56 ^{bc}	5.23 ^c	5.37 ^b	3.85 ^{ab}	5.46 ^b	4.63 ^{bc}
	3	7.14 ^c	4.90 ^{bc}	6.85 ^{cd}	3.71 ^{ab}	6.68 ^c	4.46 ^{bc}
	5	8.79 ^d	5.16 ^{bc}	7.52 ^d	4.21 ^b	6.97 ^c	4.77 ^{bc}
3% Dried Plum Puree	0	5.00 ^a	4.25 ^{ab}	4.36 ^a	4.05 ^{ab}	3.99 ^a	3.98 ^{abc}
	1	5.80 ^b	4.94 ^{bc}	4.82 ^{ab}	4.02 ^{ab}	4.90 ^{ab}	4.23 ^{abc}
	3	6.54 ^c	4.57 ^{bc}	5.17 ^b	3.60 ^{ab}	5.32 ^b	4.02 ^{abc}
	5	7.30 ^c	4.03 ^a	5.57 ^c	3.52 ^a	5.21 ^{bc}	3.94 ^{abc}
3% Plum Juice	0	5.01 ^a	4.30 ^{ab}	4.18 ^{ab}	3.85 ^{ab}	3.86 ^{ab}	4.20 ^{ab}
	1	6.11 ^{ab}	4.68 ^{bc}	4.66 ^{ab}	3.76 ^{ab}	4.60 ^{ab}	4.36 ^{abc}
	3	7.13 ^{bc}	4.59 ^b	5.48 ^b	3.77 ^{ab}	5.12 ^b	4.37 ^{ab}
	5	7.26 ^c	3.76 ^{ab}	6.50 ^b	3.48 ^a	6.46 ^b	4.14 ^{ab}

*log colony-forming units/gram

Note: Data points with like letters ^{a-d} indicate that data are not significantly different from one another, as determined by a degree of separation less than 0.05.

Source: Kansas State University, Manhattan, KS

off-flavors as a result of oxidation in fat and muscle tissue. He hypothesizes that “incorporation of dried plum puree into irradiated ground beef patties can retard lipid oxidation and reduce off-flavors generated by the irradiation process.” Working in conjunction with San Diego-based SureBeam Corporation, Keeton plans to launch the investigation early 2002.

Meanwhile, for meat product manufacturers ready to put dried plum ingredients to work in their own products, CDPB offers formulation assistance, product advice and sample formulations

at www.CaliforniaDriedPlums.org. For example, a prototype Italian sausage (28% fat) formulation calls for, by weight, 33.7% lean pork, 42.3% pork trim and a 3.3% dried plum fruit blend (consisting of a blend of dried plum puree and apple puree), along with various spices and processing aids. More interested in turkey products or ground beef than in pork? No problem — sample formulations for ground beef patties, turkey meatloaf, turkey sausage and turkey burgers also are provided at CDPB’s site.

Given the many potential formula-

tion benefits gained from incorporating dried plum ingredients into meat products, putting these multifunctional ingredients to work in meats truly qualifies as a “plum assignment.” And when the favorable economics and clean-label appeal of dried plum ingredients also are taken into account? The deal becomes even sweeter. ■

Heidi Kreuzer is a Chicago-area freelance writer. She can be contacted at KreuzerInk@aol.com.

