



GOLD SHIELD[®]
PetFoodSolutions.com

Gold Shield[®] Refined Chicken Fat:

A Multi-Benefit Ingredient
for Improving Safety,
Quality, and Efficiency for
Pet Food Manufacturers.

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Important Needs for Pet Food Manufacturers:

Manufacturers face a multitude of challenges in the production of pet food.

SAFETY: Always a top priority in every ingredient and system involved in the production process.

QUALITY: Both brand and product quality are essential, and constant improvement is a must.

EFFICIENCY: Running the best operation and doing it in a predictable, dependable, and profitable manner will determine the long-range success of a manufacturer.

At Pet Food Solutions we have heard these needs from several pet food manufacturers, and we are happy to report that we have a revolutionary product that can address them all.

Who is Pet Food Solutions?

Pet Food Solutions is a highly respected refiner of animal fats, serving unique industries including pet food production. Our processes and ingredients are driven by technology that is designed to provide multiple benefits while leading the industry in a "clean and green" approach, with zero waste. Our record of safety and quality is unmatched and we pride ourselves on providing service that aligns with the exceptional quality of our ingredients.

What is Gold Shield® Refined Chicken Fat?

Gold Shield® Refined Chicken Fat is a multi-benefit ingredient for use in pet food that has been designed to replace standard chicken fat. Gold Shield® Refined Chicken Fat will reduce the risk of Salmonella contamination, increase product stability and quality, and improve plant operations. Gold Shield® Refined Chicken Fat (now available from Pet Food Solutions, LLC) is a consistent high quality chicken fat from which most of the non-fat impurities found in standard rendered chicken fat have been removed.



How is Gold Shield® Refined Chicken Fat Produced?

Gold Shield® Refined Chicken Fat is produced using a highly automated, patent pending process. We currently produce large scale volume of Gold Shield® Refined Chicken Fat, and we are rapidly growing our capacity. Standard rendered chicken fat contains about 3% of non-fat components including inorganic salts, organic impurities, and insoluble particulates. We remove these undesirable components so they don't contaminate the pet food or affect your operations. This translates to 3% more product with every shipment. Our process carefully balances four key variables: water, pressure, heat, and time.

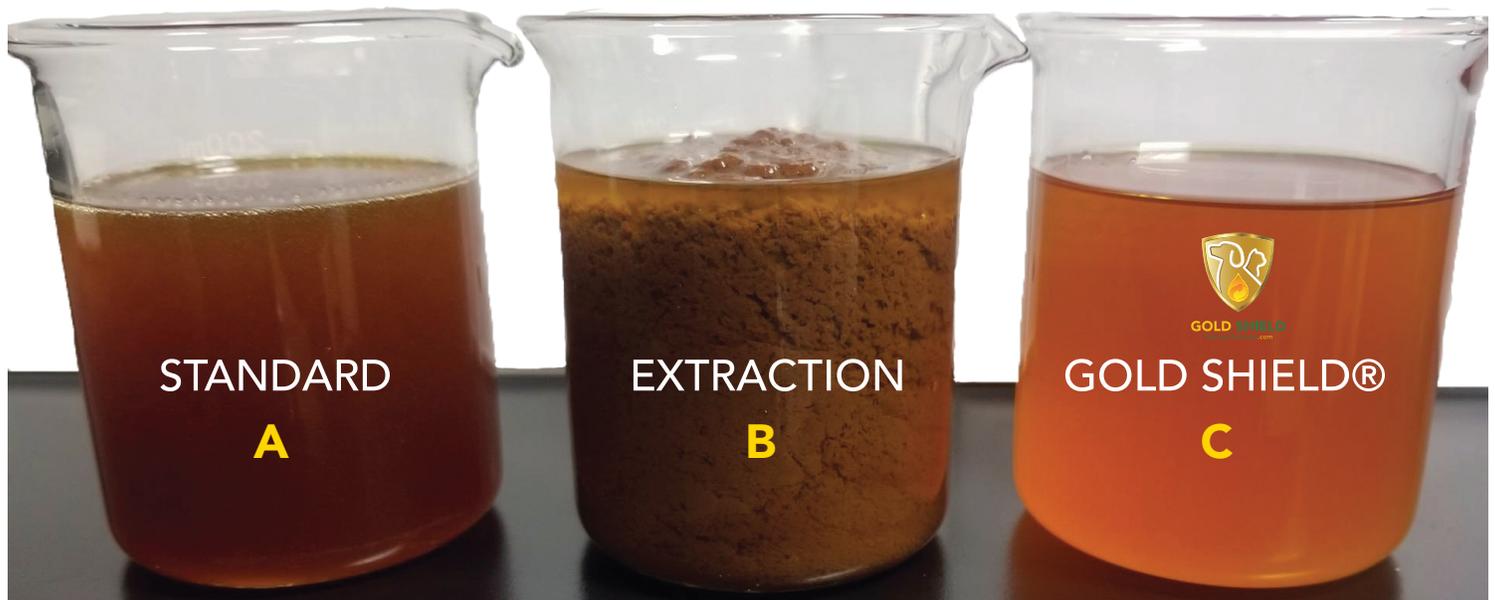
In the photo below there are 3 containers. First (A), the raw materials most manufacturers use now. Second (B) is the extraction material we remove, and third (C) is our Gold Shield® Refined Chicken Fat. We treat the standard fat and then separate the not-fat components from the purified fat. The non-fat components of the extraction material are used for land application and any additional oil is used for bio-diesel production, so our process does not generate any waste. Gold Shield® Refined Chicken Fat provides the pure fat food value of chicken fat without the impurities that can cause problems in pet food production, and in the quality of the formulated pet food.

Our processing is the key to providing a high quality and safe ingredient. Beyond removing chemical impurities, our processing will also remove microbial impurities. To test this hypothesis, we inoculated standard rendered chicken fat in water with *Salmonella*, and then submitted the sample to simulated process conditions. *Salmonella* was killed in under 5 minutes giving us a significant safety margin during our processing.

Experiments Conditions	CELL POPULATION			
	Time (min)	CFU/mL	Log 10	Log Reduction
Salmonella newport	0	1.56E +10	10.19	-
Sample = CF 2018-56a	1	730	2.89	-7.3
Low Process Temperature	2	2	.3	-9.89
0.5 mL CF + 0.5 mL of cell is in TSB	3	0	-	-
	10	0	-	-
	30	0	-	-

If any *Salmonella* were to enter our process from the standard chicken fat, it would be quickly killed. Therefore, we are confident about the microbiological quality of Gold Shield® Refined Chicken Fat, and we have a specification of undetectable levels of *Salmonella* as tested by a third-party lab on every batch.

→ Realize 3% more product with every Gold Shield® shipment ←



How Does Gold Shield® Refined Chicken Fat Differ From Standard Chicken Fat?

Chicken fat is an important ingredient in a pet's diet to provide energy, help cells and organs function well, and support a healthy skin and coat. Gold Shield® is one of the purest forms of chicken fat on the market.

The benefits of chicken fat are obtained with Gold Shield® Refined Chicken Fat without the problems associated with the non-fat components that usually accompany the standard grades of chicken fat. Because the fatty acid profile is not different from the standard grades, no labeling change is required to fully utilize Gold Shield® Refined Chicken Fat instead of standard chicken fat. As noted above, our customers use ALL of the product we ship them. Because we remove the impurities, you won't have to. This translates to 3% more product with every load, and is only one of the ways this product adds value to pet food manufacturers.

Gold Shield® Refined Chicken Fat is a translucent amber to medium brown colored product that looks and performs differently from standard rendered chicken fat. The Table below shows a comparison between Gold Shield® Refined Chicken Fat and standard chicken fat on a typical batch. Although the non-fat components in the fat have been



REFINED CHICKEN FAT: TYPICAL ANALYSIS VS. STANDARD CHICKEN FAT

	Refined Chicken Fat	Standard Chicken Fat	Fatty Acid Profile (Avg wt-%)	Refined Chicken Fat	Standard Chicken Fat
Moisture (Avg wt-%)	0.40	0.18	C12 Lauric Acid	0.06	0.05
Insolubles (Avg wt-%)	0.08	0.24	C14 Myristic Acid	0.56	0.63
Unsaponifiables (Avg wt-%)	0.99	0.92	C14:1 Myristoleic Acid	0.17	0.18
Total MiU (Avg wt-%)	1.47	1.33	C16 Palmitic Acid	23.90	24.32
Free Fatty Acids (Avg wt-%)	2.75	3.15	C16:1 Palmitoleic Acid	6.64	6.58
Peroxide Value (meq/kg)	0.70	0.70	C16:2 Hexadecadienoic Acid	0.00	0.02
METALS AND SALTS			C17 Margaric Acid	0.11	0.09
Iron (ppm)	<1.0	1.8	C17:1 Margaoleic Acid	0.08	0.03
Magnesium (ppm)	<1.0	4.2	C18 Stearic Acid	5.83	5.99
Calcium (ppm)	5.1	15.9	C18:1 Oleic Acid	39.90	39.94
Phosphorus (ppm)	6.4	280.9	C18:2 Linoleic Acid	20.39	19.73
Sodium (ppm)	2.0	48.0	C18:3 Linolenic Acid	1.25	1.22
Potassium (ppm)	4.6	82.4	C20 Archidic Acid	0.06	0.08
Sulfur (ppm)	26.3	43.2	C20:1 Eicosenoic Acid	0.33	0.29
FAC Color	Translucent Amber to Medium Brown		Total FFA (wt-%)	99.28	99.10
Physical Appearance	Mobile Liquid				
Flavor/Odor	Neutral/Bland				



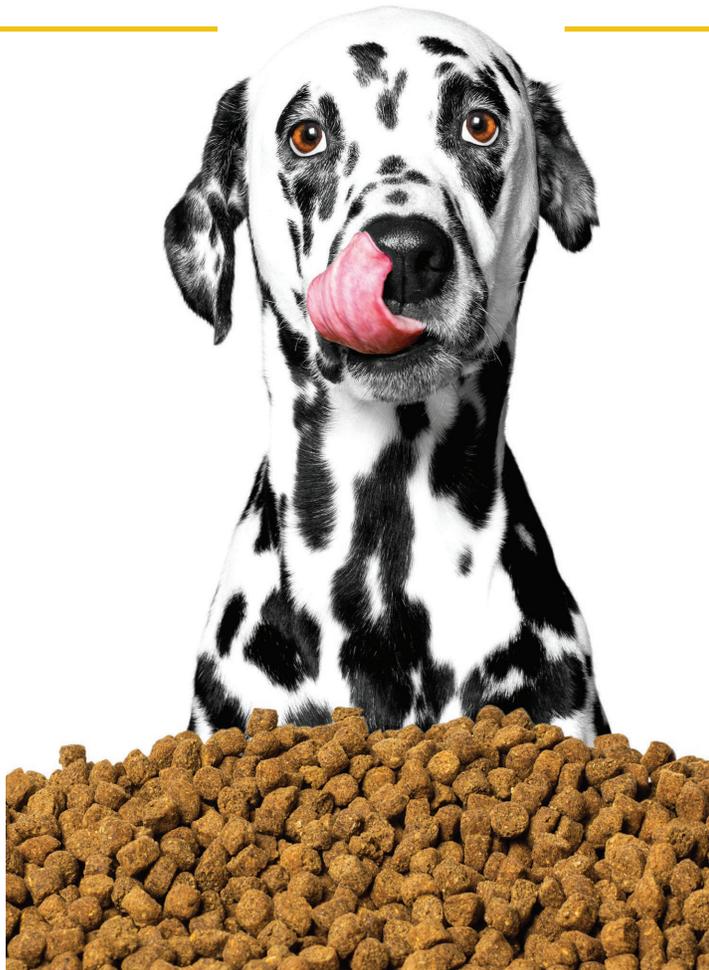
significantly reduced, the fatty acid profile of Gold Shield® Refined Chicken Fat is the same as the standard chicken fat. For example, the linoleic acid content that is important for coat health is the same in Gold Shield® Refined Chicken Fat as that in standard chicken fat (about 20 wt-%).

The benefits from the fat are maintained, but many of the problems associated with the standard chicken fat are eliminated. Most of the insoluble material that can cause clogs in lines and residue in storage tanks is removed from the standard fat. The table above showed that typically a 67% reduction in insoluble material is observed (reduced from 0.24% to 0.08%). What this means for the manufacturer is far fewer unscheduled line stops, requiring maintenance and costing valuable production time.

Soluble impurities are also decreased. The soluble impurities include metals which are known to be catalysts for oxidation. On average, metal levels (e.g. iron and magnesium) are reduced from 2-4 ppm to less than 1 ppm.

Levels of inorganic water-soluble salts such as phosphate and sulfates are decreased. The phosphorus content can decrease by over 95% (from 280 ppm to 6 ppm). Organic water-soluble impurities (e.g. nucleic acids, and amino acids) are also removed. These organic impurities can function as pro-oxidants that impact product stability and nutrients for microbial growth.

The use of Gold Shield® Refined Chicken Fat allows for the production of a precisely formulated diet achieving all the benefits of pure chicken fat without the problems associated with the non-fat impurities in standard chicken fat.



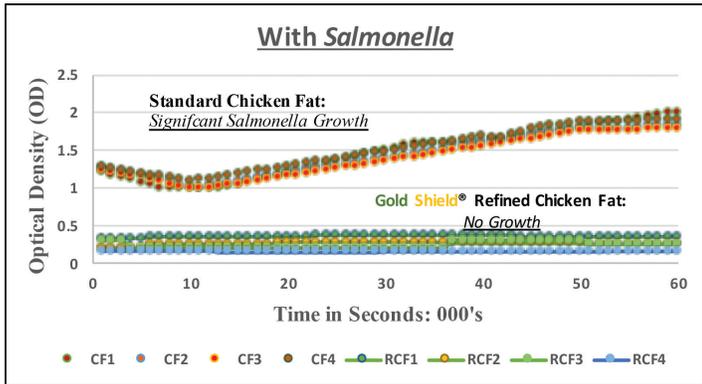
Benefits of Gold Shield® Refined Chicken Fat

SAFETY

Gold Shield® Refined Chicken Fat was designed to provide many benefits to the pet food manufacturer, pet food consumers and ultimately to pets. It all starts with improved safety by reducing the risk of *Salmonella* contamination of pet food. The FDA has a zero-tolerance policy for *Salmonella* contamination in pet food and treats. *Salmonella* has led to over 33% of all recalls in 2018-2020¹, and all manufacturers need to proactively reduce the possibility of *Salmonella* contamination in their products.

Salmonella contamination of pet food often occurs through *Salmonella* contamination of the chicken fat ingredient since it is typically added to coat the extruded pellet after the high temperature kill step in the process.² Any *Salmonella* contamination of the chicken fat could result in contamination of the food itself.

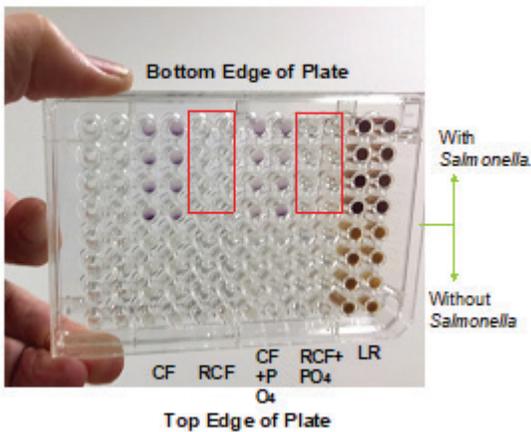
Relatively low water activity products like chicken fat were thought to not harbor *Salmonella*, but it is now known that if water is present (and it is almost always present due to water in transfer lines and vessels used during transportation) *Salmonella* can survive and grow.³ A key



to the growth is the level of nutrients in the chicken fat that can be easily metabolized by *Salmonella*. These key nutrients for *Salmonella* growth in chicken fat include water, essential metals, and organic materials (e.g. amino acids and nucleic acids).

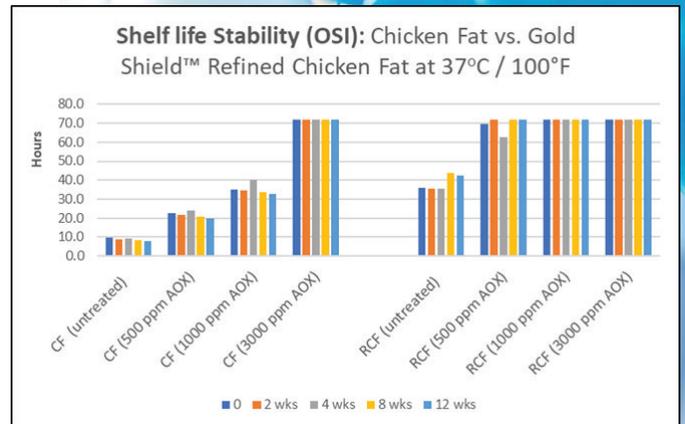
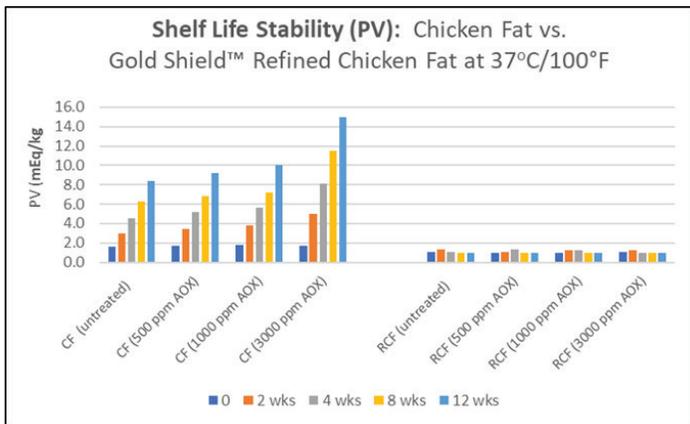
Gold Shield® Refined Chicken Fat has been designed to be bacteriostatic to *Salmonella* contamination. By removing the non-fat components in standard chicken fat, we remove the nutrients necessary for *Salmonella* growth. Even if water is present *Salmonella* is unable to grow in Gold Shield® Refined Chicken Fat.

To prove this concept, we designed an experiment using a 96 well plate (picture left). The wells were charged with either standard chicken fat or with Gold Shield® Refined Chicken Fat. Some of the wells were challenged with *Salmonella* cells (others were maintained as controls), and all of the wells were monitored for growth over 24 hours. The results are shown in the graph above. All the wells of standard chicken fat showed significant *Salmonella* growth and all the wells with Gold Shield® Refined Chicken Fat showed no growth. By removing the non-fat components from standard chicken fat, Gold Shield® Refined Chicken Fat is proven to be bacteriostatic against *Salmonella* contamination. When Gold Shield® Refined Chicken Fat is used instead of standard chicken fat in a pet food formulation, the risk of *Salmonella* contamination of the pet food will be significantly reduced.



STABILITY

Gold Shield® Refined Chicken Fat is significantly more stable and resistant to oxidation than standard chicken fat. Peroxide value (PV) is a measure of oxidation that has occurred in a food or ingredient due to exposure to air. We have measured PV at 37°C (100°F) of both standard chicken fat and Gold Shield® Refined Chicken Fat over a 12-week time frame and the results are shown in the graph below. No significant oxidation occurred in Gold Shield® Refined Chicken Fat while considerable oxidation occurred in standard chicken fat even when antioxidants (standard mixed tocopherols) were added at various levels. Even with 3000 ppm antioxidant, the PV increased from about 2 to over 14 mEq/kg over the 12 weeks in the standard chicken fat. The PV for Gold Shield® did not change in that same time period.



Another measure of stability is the Oxidative Stability Index (OSI). OSI characterizes the resistance of oils, fats and fat-containing foods to oxidation under forcing conditions by bubbling air through the material at elevated temperatures. The OSI is generally expressed in hours and can be used to estimate how quickly a fat or oil will become rancid. We compared the OSI of Gold Shield® Refined Chicken Fat to standard chicken fat at 37°C (100°F) over a 12-week time frame again and the results are in the graph above. This graph shows that Gold Shield® Refined Chicken Fat has about the same stability (as measured by OSI) to standard chicken fat with 1000 ppm of antioxidant (standard mixed tocopherols). Another way to look at it, is that 500 ppm antioxidant in Gold Shield® gives similar stability as 3000 ppm of antioxidant in standard chicken fat.

This means that customers can consider lower levels of antioxidant in Gold Shield® Refined Chicken Fat compared to what they currently use in standard chicken fat.





IMPROVED OPERATIONS

Current customer feedback has provided real world examples of the efficiency benefits for Gold Shield® Refined Chicken Fat. Because of the lack of materials which can clog lines and nozzles, fewer unscheduled maintenance stops are required. Also, fewer tank cleanings are required with this product over time. The value of this extra benefit can be a material difference, resulting in tens or hundreds of thousands of dollars per year. Most manufacturing facilities put a high premium on materials that improve efficiency and save cost, and this has been reflected in the feedback from current users.



PALATABILITY

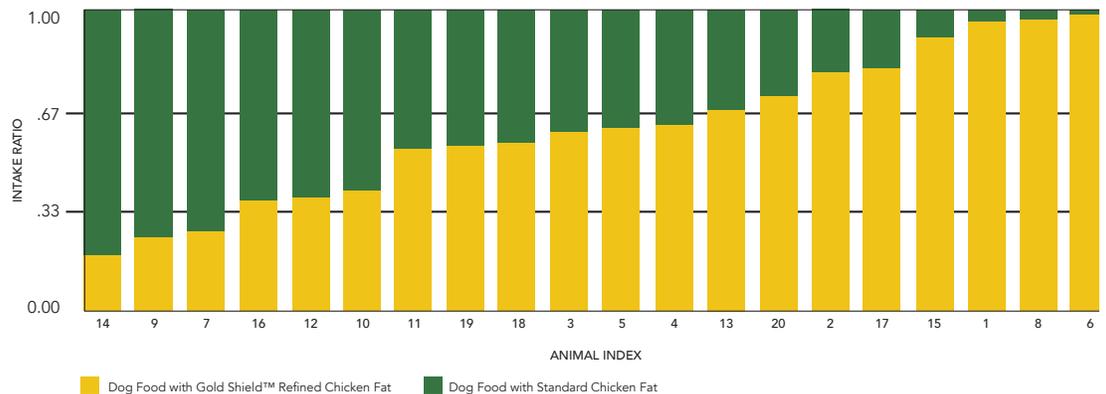
Gold Shield® Refined Chicken Fat provides all of the noted benefits above, while maintaining or slightly improving the palatability of pet food formulations. We have evaluated the palatability of pet food formulations made with Gold Shield® Refined Chicken Fat compared to pet food formulations made with standard chicken fat in side-by-side tests. Gold Shield® Refined Chicken Fat performed at parity or was slightly preferred in all the tests that we have run either independently or with customers. These tests were conducted with dogs specifically.

In one independent study, we produced a fat coated kibble with one of our customers. Everything in the formulation was identical except that the first sample of dog food was produced with standard chicken fat and the second sample of dog food was produced with Gold Shield® Refined Chicken Fat. We then compared the palatability of the dog food by presenting both dog foods to twenty beagles over two days and monitoring the total consumption and the first choice.

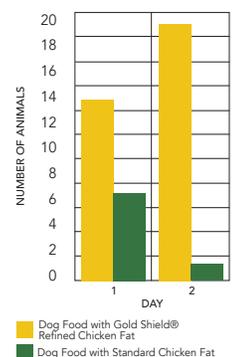
The results above show the preference of the beagles after storing the dog food in a bag for 10 weeks. The product was tested at this time to replicate the typical supply chain, and the likely product as it would be purchased by the consumer. For this formulation our Gold Shield® Refined Chicken Fat was preferred, and the pets chose food made with Gold Shield® Refined Chicken Fat first.

Every formulation is different of course including ingredients, type and quantity of palatants, and other factors. Your results will depend on these variants and we encourage testing to determine all of our benefits. Pet Food Solutions is also continuing research on palatability on kibble coated with Gold Shield® Refined Chicken Fat.

Consumption Ratio



First Preference



The Value of Gold Shield® Refined Chicken Fat

GOLD SHIELD® RCF TECHNOLOGY FEATURES	BENEFIT	IMPLICATIONS FOR MANUFACTURERS
Bacteriostatic Properties	<ul style="list-style-type: none"> RCF process kills bacteria and removes bacterial contaminants Inhibits future Salmonella growth 	<ul style="list-style-type: none"> Improved consumer food safety by eliminating <i>Salmonella</i> product contamination - risk of recalls, etc Lowers process & plant worker risk of exposure
Improved Operations Efficiency	<ul style="list-style-type: none"> Residual, non-fat compounds are eliminated 	<ul style="list-style-type: none"> Easier to handle/pump - reduced agitation Reduced process maintenance and cleanup cost - extend run times, simplify cleaning, etc.
Much Better Stability: - Higher Purity - Process Consistency	<ul style="list-style-type: none"> Far better shelf life and product quality Lot-to-lot uniformity - tighter specifications RCF process eliminates non-fat impurities 	<ul style="list-style-type: none"> Cost savings on expensive antioxidants Minimize process variation, expense Higher nutrient density - pure fat - no "extras"
Supports "Clean Label" E.U. Certification	<ul style="list-style-type: none"> Labeled simply as "Chicken Fat" Value for exporters 	<ul style="list-style-type: none"> No charge, cost impact vs. current label Key benefit to serve markets beyond U.S.
Clean & Green Model for Pet Food Scrutiny <i>(increasing constantly)</i>	<ul style="list-style-type: none"> No chemicals in our refining process Focused on sustainability ZERO waste - full circle process 	<ul style="list-style-type: none"> Natural from start to finish Sustainable process with large scale ease Environmentally friendly technology
Palatability Performance	<ul style="list-style-type: none"> Parity or better in testing vs. standard higher-risk chicken fat 	<ul style="list-style-type: none"> Protects (may enhance) palatability and quality Pets & pet owners love the product
Limits Need for Additives	<ul style="list-style-type: none"> Minimal microbial load reduces need for chemical additives 	<ul style="list-style-type: none"> Ingredient, handling, and process cost, simplification and control
Potential Health Benefits	<ul style="list-style-type: none"> Reduced salts and metals 	<ul style="list-style-type: none"> Possible joint and kidney health improvement

About James C. Peterson

Dr. James Peterson is the Technical Consultant at Pet Food Solutions, LLC. Dr. Peterson joined the PFS team in 2018 and has led the efforts to define and characterize our products by designing and implementing scientific studies in collaboration with outside research institutions. Prior to coming to PFS, he held multiple leadership positions in research and development at Novus International, Pfizer, Pharmacia, and Monsanto. He earned a Bachelor of Arts degree in Chemistry in 1977 from Lawrence University in Appleton, Wisconsin. He then earned his Ph.D. in Synthetic Organic Chemistry in 1984 from Northwestern University. Over the course of 35 years in research and development, he has nineteen patents and publications.

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¹ FDA Website

² Jones, F. T. A review of practical Salmonella control measures in animal feed. 2011. Journal of Applied Poultry Research 20:1 102-113

³ Finn, Sarah, Condell, Orla., McClure, Peter, Amézquita, Alejandro, and Fanning, Séamus. Mechanisms of survival, responses, and sources of Salmonella in low-moisture environments. 2013. Frontiers in Microbiology 4, Article 331, 1-15