

FERMENTATION AND HISTAMINE

By Chelsea Kent and Roxanne Stone

At Solutions Pet Products, we believe that the key to creating healthy and safe pet food is with natural fermentation methods. In this blog, we will be discussing the benefits of lactic acid fermentation and how we can produce low-histamine pet food while enhancing nutrient content. We will also be delving into the science behind this ancient preservation technique and its ability to mitigate pathogens, making it an essential safety feature in our pet food products. Join us as we explore the fascinating world of lactic acid and salt fermentation and discover the many benefits it has to offer for our pets' health and well-being.

What is fermentation and how does it work?

Fermentation is a metabolic process by which microorganisms such as bacteria, yeasts, and fungi convert carbohydrates and other organic compounds into useful products such as alcohol, acids, gases, and various other compounds. It is an ancient process used for food preservation. During fermentation, microorganisms break down the complex sugars and other compounds in the food substrate into simpler compounds such as lactic (lactobacillus) acid, ethanol, carbon dioxide, and various other organic acids. These have beneficial properties such as acting as natural preservatives, enhancing nutrient content, and improving digestibility.

What type of fermentation does Solutions Pet Products use?

Solutions Pet Products uses lactic acid fermentation and salt fermentation.

Lactic (lactobacillus) Acid fermentation is a type of fermentation that is used on dairy products. The word "lactic" originates from the Latin term "lacticus," or "lac," meaning "milk." All mammals produce and consume milk. This makes us unique because we have developed the perfect food for our own species. Lactic acid, which is like our natural sugar and fuel, plays a crucial role in this process. As mammals (animals that drink milk), our cells have evolved to use lactic acid as their source of energy. It efficiently powers the cells of mammals, enabling them to have a strong and fast metabolism.

Solutions Pet Products uses this type of fermentation on our GOATnog, TEXsauce, Better Butter goat milk Tea, and Tummy Butter Kefir Tea, duck eggs, chicken eggs, and cheese. Lactic Acid Bacteria (LABs) initiate the fermentation process through a series of enzymatic reactions. LABs consume the available sugars in the food or beverage. This is facilitated by enzymes such as invertase, which hydrolyzes sucrose into its component sugar in a process called glycolysis. This process generates energy for the bacteria and also helps to lower the pH of the food, creating an environment that is inhospitable to harmful bacteria.

Salt fermentation is a type of fermentation that is commonly used for vegetables. In Solutions Pet Products this process is used in our TEXsauce, Chicken Jiggles, Fish Jiggles, and in our diets. We salt ferment our ginger, turmeric, herring, cod liver, cod-liver oil, and okra. Salt fermentation is a process that creates an osmotic pressure that dehydrates the cells of any harmful bacteria that may be present, which causes them to die off. It creates an environment that is more favorable for the growth of lactic acid bacteria, which are able to thrive in the salty and acidic conditions created by the fermentation process.

What about lactose intolerance and lactic acidosis?

Lactic acid gets a bad reputation due to misunderstood conditions such as Lactose Intolerance and Lactic Acidosis.

Lactose Intolerance is not a normal occurrence in adult mammals. Milk consumption is not something that mammals outgrow; rather, it is caused by a gut infection. Lactose intolerance is primarily caused by a deficiency of an enzyme called lactase. Gastroenteritis, SIBO (small intestinal bacterial overgrowth), and parasitic infections (such as giardia) will all impair lactase production and function. When this occurs pasteurized milk products that have neutralized their naturally occurring lactase enzymes will cause lactose intolerance. Alternatively, raw milk still contains the lactase enzyme, thus reducing the likelihood of intolerance and providing competitive bacteria to combat SIBO, giardia, and other gut imbalances.

Lactic Acidosis happens when athletes' cells accumulate too much lactic acid because they have depleted their calcium and thiamine resources, which are necessary for metabolizing it, or it can be produced by cancer cells or in mishandled diabetic states. Initially lactic acid fuels activity, but once the body runs out of the required nutrients problems arise. Lactic acidosis is a condition of nutrient deficiency, impaired metabolism, cancer, insufficient oxygen supply, or inherited metabolic disorders. In healthy individuals, lactic acid is produced by the body during intense exercise and is efficiently cleared by the liver and other tissues. The consumption of lactic acid bacteria (lactobacillus) does not contribute to lactic acidosis or cause of lactic acid metabolism impairment.

Can fermentation improve the nutritional value of foods? If so, how?

Fermentation can lower sugars and optimize ketosis-inducing ratios.

In general, the longer the fermentation process, the greater the reduction in sugar content. For example, a study on the fermentation of okra found that after four days of fermentation, the total sugar content was reduced by approximately 50% compared to fresh okra. Similarly, a study on the fermentation of apples found that after four weeks of fermentation, the total sugar content was reduced by approximately 50% compared to fresh apples.

Fermentation can increase B-Vitamin and Amino Acid levels in foods.

During fermentation, microorganisms such as bacteria and yeasts metabolize the carbohydrates and proteins present in the food substrate, leading to the production of various metabolites, including B vitamins and amino acids. Some species of lactobacillus bacteria (lactobacillus plantarum, brevis, fermentum, helveticus, lactis, casei, Lactococcus lactis, streptococcus thermophilus, and Bifidobacterium bifidum) produce B vitamins such as thiamine, riboflavin, folate, vitamin B12 as well as Vitamin K2 during fermentation. These microorganisms have the ability to synthesize these vitamins from precursor yeast molecules present in the food substrate. Similarly, certain strains of yeast and bacteria are capable of producing amino acids such as glutamic acid and lysine during fermentation. In a study of lactic acid fermentation of kimchi, the folate content increased by up to 125% compared to raw cabbage, while the riboflavin content increased by up to 60% (1).

Amino acids, such as glutamic acid and lysine, can also be produced during fermentation by certain strains of lactic acid bacteria (lactobacillus fermentum, delbrueckii, brevis, plantarum, and helveticus) and yeasts. For example, in a study of the fermentation of soybean meal, the glutamic acid content increased by up to 68% compared to unfermented soybean meal, while the lysine content increased by up to 33% (2).

Which strains of lactobacillus bacteria are in Solutions Pet Products?

Solutions Pet Products contain Lactococcus lactis, lactobacillus lactis, streptococcus thermophilus, lactobacillus bulgaricus, lactobacillus casei, Bifidobacterium bifidum, pediococcus spp., leuconostoc spp., weissella spp..

These bacteria produce organic acids such as lactic acid, acetic acid, and formic acids, as well as bacteriocins which are proteinaceous antimicrobial peptides that can kill or inhibit the growth of other bacteria as well as prevent spoilage.

Does fermentation improve the safety of foods? If so, how?

The lactobacillus lactic acid bacteria found in Solutions Pet Products have been scientifically proven to inhibit or kill Staphylococcus aureus, Escherichia coli, Salmonella spp. (S. Enterica, S. Salamae, S. Arizonae, S. Diarizonae, S. Houtenae, S. Indica), Listeria monocytogenes, various species of Clostridium and Bacillus (cereus).

Lactobacillus casei and Bifidobacterium bifidum have been proven to produce additional beneficial compounds including bacteriocins and vitamins.

If Salmonella spp, Listeria monocytogenes, and E.coli were present in low levels in a food product that was properly fermented for 24 hours at room temperature, a decrease of 1-2 log CFU/g (90-99% reduction) would be expected.

Is fermentation a problem for pets with allergies or mast cell disorders/diseases?

Histamine's association with fermentation is a misunderstood topic.

First, it's important to clarify that histamine is essential to the body. Histamine is manufactured from the essential amino acid Histidine. Histamine is a biogenic amine that plays an essential role in various physiological processes in the body. It is synthesized and stored in mast cells and basophils and is released in response to an immune response or an allergic reaction. Histamine acts as a neurotransmitter in the brain and is involved in the regulation of sleep-wake cycles, alertness, appetite, and learning and memory. It also plays a critical role in the regulation of gastric acid secretion, which aids in the digestion of food. Additionally, histamine is involved in the regulation of the immune system, acting as a pro-inflammatory mediator to recruit immune cells to sites of infection or injury.

Histamine levels in the body are regulated by a complex balance between histamine production and breakdown. In individuals with normal histamine metabolism, the threshold for histamine intolerance or allergic reactions can vary widely and depend on factors such as age, genetics, and overall health. However, in individuals with impaired histamine metabolism or a genetic predisposition to histamine intolerance, even small amounts of histamine can trigger symptoms.

Multiple factors can contribute to histamine intolerance:

- 1) Deficiency of the enzyme diamine oxidase (DAO), which is responsible for breaking down histamine in the digestive tract. Indirectly, deficiencies of Vitamins A, E, and D, mineral imbalances, and heavy metal toxicities can degrade the body's immune function, potentially leading to immune-related disorders, some of which may contribute to histamine intolerance directly. Additionally, nutritional imbalances can potentially inhibit the production of DAO. (Elevated mercury and Vitamin B6 deficiency are the most likely to inhibit DAO production). Those with histamine intolerance tend to be deficient in DAO, leading to an inability to break down ingested histamine. DAO supplements are available online.
- 2) Certain medications, non-steroidal anti-inflammatory drugs, and antibiotics can inhibit DAO activity.
- 3) Histamine is also broken down in the body by the enzyme histamine N-methyltransferase (HNMT). HNMT breaks down histamine that is produced by the body. Individuals with histamine intolerance have a deficiency of HNMT, leading to a buildup of histamine in the body.
- 4) Overconsumption of high-histamine foods such as aged cheese (20-300mg/100g), improperly or excessively fermented foods (500-3,000mg/100g), and cured meats (30-700mg/100g).
- 5) Some foods are not high in histamine themselves but can trigger the release of histamine in the body such as dried fruits (0.5-10mg/100g), avocados (0.5-5mg/100g), eggplant (0.01-0.015mg/100g), spinach (0.8-20mg/100g), shellfish (5-250mg/100g), bananas (0.05-0.1mg/100g), tomatoes (0.005-0.2mg/100g), beans/lentils (3-10mg/100g), vinegar (0.05-0.3mg/100g), papaya (0.1-0.5mg/100g), citrus fruits (0.02-0.05mg/100g), nuts (especially walnuts (0.1-1.5mg/100g), cashews (0.3-3mg/100g), and peanuts (3-10mg/100g)), and food dyes, benzoates, sulfites, artificial flavors, and preservatives. (Histamine levels are not typically measured in additives but they are known to trigger histamine release). An average, healthy individual should be able to easily tolerate 15mg of histamine intake per 10lbs of body weight per day.
- 6) Metabolic and hormonal disorders such as adrenal fatigue, thyroid dysfunction, and mast cell activation syndrome can also contribute to histamine intolerance.
- 7) Parasitic infections have been known to cause an increase in histamine levels in the body, which can lead to symptoms of histamine intolerance. This is because some parasites (including *Giardia lamblia*) have the ability to release histamine or trigger the release of histamine from immune cells as part of their immune evasion strategies. Parasitic infections can also lead to inflammation and damage to the intestinal lining, which can impair DAO production and function.
- 8) Stress, environmental toxins, and genetic factors may also play a role.

In general, symptoms of histamine intolerance or allergic reactions can occur when histamine levels exceed the body's capacity for breakdown or when histamine is released in excess by immune cells such as mast cells. Mast cells contain granules filled with various substances (proteoglycans, cytokines, chemokines, growth factors, tryptase, chymase, heparin, VEGF, FGF, PDGF), including histamine, which they release in response to certain triggers. While histamine is a contributor to triggering irritation of the cells, dysfunction of associated "mediator" compounds can contribute to symptoms and tissue damage. Eliminating histamine, therefore, is not the only factor in resolving problems. Full body balance and support are imperative. The symptoms can vary widely and may include skin rash, hives, itching, flushing, gastrointestinal symptoms,

headache, heart palpitations, and low blood pressure. The severity of symptoms can also vary widely, from mild discomfort to life-threatening anaphylaxis.

What foods are highest in histamine?

Histamine levels do, indeed, elevate with fermentation. However, it's all still relative. So here are some examples of what that looks like:

	Fresh	Cured	Fermented or Rotting
Beef	0.1-0.2mg/100g	4.4-30mg/100g	40-160 mg/100g
Pork	0.2-0.4mg/100g	0.8-26mg/100g	60-210 mg/100g
Chicken	0.02-0.05mg/100g	0.5-6.7mg/100g	20-60 mg/100g
Whitefish	0.2-1mg/100g		50-80mg/100g
Herring	0.5-2mg/100g		500-600mg/100g
Eggs	<0.1mg/100mg		<3-20mg/100g
Okra	<0.2mg/100g		<25mg/100g
Ginger	<0.1mg/100g		<25mg/100g
Turmeric	<0.1mg/100g		<25mg/100g
Raw Milk	0.03-0.3g/100g		18-60mg/100g (yogurt)

It's important to note that these are rough estimates, and the histamine levels in foods can vary widely depending on various factors. And as stated above, histamine levels alone may not necessarily predict whether a food will trigger histamine intolerance symptoms.

Variables that can decrease or increase histamine levels in final products include:

- 1) Using contaminated equipment or ingredients: Histamine-producing bacteria can be present on the surface of fruits, vegetables, and other ingredients used in fermentation. Using contaminated equipment or ingredients can introduce these bacteria to the fermentation process and increase histamine levels.
Solutions Pet Products only produces one product type then fully shuts down equipment and sanitizes between batches. We never run two proteins or batches on the same day – thus eliminating cross-contamination or stagnation in our production.
- 2) High temperatures: Histamine-producing bacteria thrive in warm environments, so higher temperatures during fermentation can lead to increased histamine production. Temperatures above 104°F are considered “high” for most ferments. Temperatures above 77°F are considered high for some vegetables.
Solutions Pet Products products and ingredients that are fermented are produced at either refrigerated temperatures or if in a warm environment, at temperatures under 80°F. To ferment our milks, we never bring temperatures above 82°F. Our vegetables are never fermented at temperatures above 75°F.
- 3) Extended fermentation time: longer fermentation times can provide more time for histamine-producing bacteria to grow and produce histamine. Some food products ferment for as long as several months.
Solutions Pet products ferments for a period of 3 to 7 days, depending on the ambient temperature.
- 4) Lack of oxygen: Histamine-producing bacteria are anaerobic, meaning they thrive in environments with low oxygen levels. Fermenting food in an oxygen-deprived environment can encourage the growth of these bacteria.
Solutions Pet Products produces using both aerobic and anaerobic environments, allowing for a combination of, and greater diversity of microorganisms and their beneficial by-products.
- 5) High salt concentration: Some studies suggest that high salt concentrations during fermentation can contribute to increased histamine production. The amount of salt that is considered a "high salt contribution" when fermenting foods can vary depending on the specific food being fermented and the fermentation process being used. However, in general, a high salt concentration during fermentation is often defined as a salt content of 5% or more by weight. Salt plays a crucial role in the fermentation process by inhibiting the growth of harmful bacteria and creating an environment that is conducive to the growth of beneficial bacteria. However, using too much salt during fermentation can lead to overly salty or unpalatable foods and can also impact the final texture and flavor of the food. It's worth noting that the ideal salt concentration for fermentation can vary depending on the type of food being fermented, the fermentation method being used, and personal taste preferences. Many recipes for fermented

foods will provide specific salt concentrations, and it's generally a good idea to follow these guidelines closely to achieve the desired results.

Solutions Pet Products ferments our okra and ginger in salt. We never use more than 2% salt brine solution.

Solutions Pet products ferments the following ingredients:

- Okra
- Ginger
- Turmeric
- Duck and Chicken Eggs (with and without shells)
- Whey
- Herring
- Cod Livers

Solutions Pet Products does NOT ferment the following ingredients:

- Our meats, organs, or bones
- Kale or parsley
- Chia Seeds, though we do fresh sprout them!
- Wheat germ oil
- Kelp

While Solutions Pet Products uses some fermented ingredients, we do not ferment our entire diets, thus controlling the overall histamine concentration in our diets.

Should you avoid foods that contain or stimulate histamine?

Whole food ingredients contain numerous synergistic compounds. For example, methionine and tryptophan can be inflammatory in individuals with IBD/IBS. Vitamin A can be inflammatory in individuals with certain genetic mutations. Vitamin D is inflammatory in excessively high levels and in those with certain genetic mutations. Iron, Calcium, and Vitamin C are inflammatory in those with hemochromatosis. Omega 6 fatty acids can be inflammatory in individuals with liver dysfunction or intestinal inflammation. Additionally, environmental and dietary contamination can contribute to health crises. Contaminants such as glyphosate, excessive copper, MSG, artificial colors, BHA/BHT/Propylene glycol/Polysorbate 80 preservatives, carrageenan, and sulfites are just a few food contaminants that can contribute to inflammation.

In short, naturally occurring nutritious compounds have the potential to cause inflammation in individuals with health problems. Therefore, individual compounds within any food should not be the determining factor on whether or not it's best for your pet.

When determining what to feed a pet with possible histamine intolerance, it's important to compare the options and determine which one you feel is the best for your pet based on that comparison. For example:

1) **Restricted DIY diet** – To create a low histamine DIY diet you would have to ensure your meat sources are extremely fresh and exclusively from naturally fed/naturally finished sources, you would have to limit fruits, veggies, and carbohydrate-rich grains. You would have to ensure nutritional adequacy using supplements that contain no contaminants, sugar, or sugar alternatives and are properly balanced. Keeping in mind that nutritional imbalances may contribute to histamine intolerance. This is a complicated and expensive way to feed if done correctly. If you choose to feed DIY, formulate using www.AnimalDietFormulator.com.

2) **Commercially available fresh food that contains no fermented ingredients** – If the sourcing is very clean and fresh and the diet is nutritionally complete this may be a good option for you. Remember that foods that contain less than 25% organ content require mineral supplementation to attain nutritional adequacy. Most brands supplement with synthetic minerals which may be contaminated or inadequately blended or researched. Additionally, any ingredient that is not fresh and has begun decomposition will have elevated histamine levels.

3) **“Limited ingredient” dry food diets** – Even limited ingredient diets will contain synthetic supplements, inflammatory high carbohydrate loads, and carcinogenic byproducts (acrylamides, heterocyclic amines, polycyclic aromatic hydrocarbons)

from cooking. Most heat-processed pet foods contain meats from sources that have begun decomposition which dramatically increases histamine levels.

4) **Solutions Pet Products Meat Diets** - That said, levels of histamine can vary widely depending on the type of food, the fermentation conditions, and other factors.

If you are feeding a product such as Solutions that is intentionally and properly fermented, you are not going to feed high histamine levels. As previously stated, a healthy individual should be able to handle 15mg of histamine per day per 10lbs of body weight. Solutions diets contain an average of 0.09-2.63mg of histamine per 100g (3.5oz). This would be equal to an intake of <1.7mg/day for an average 10lb dog.

Solutions Fish Jiggles contain an average of 0.05-28mg of histamine per 100g (3.5oz). This would be equal to <8mg/day for an average 10lb dog (though, due to Solution's responsible fermentation, levels are much more likely to be 0.014mg/day for an average 10lb dog)

Solutions TEXsauce is the most fermented of all the blends and contains 0.03-2mg of histamine per 100g (3.5oz). This would be equal to <0.6mg/day for an average 10lb dog.

Keep in mind that if you are feeding a kibble product that is not fermented but sources ingredients from condemned, rendered meats (meat meals) or rotten fruits/veggies you will have higher histamine levels than you would with a fermented fresh food product. In addition, you would be exposing your pet to carcinogens and chemicals from heat processing, and likely heavy metals from synthetic mineral supplementation.

How does Solutions Pet Products formulate?

Solutions Pet Products formulates to ensure nutritional adequacy. This, alone, can reduce histamine response and support proper immune, mineral, and endocrine health.

We source to ensure our products are free of heavy metals, antibiotics, and other histamine-stimulating medications.

We do not use high-histamine or histamine-stimulating ingredients in our products.

Unsupplemented diets that are 80/10/10 are low in minerals. Diets without proper supplementation are deficient in vitamins that support endocrine and mineral activity.

Our diets are anti-inflammatory. They are low in carbohydrates, free of chemical contaminants, properly balanced, and contribute numerous anti-inflammatory ingredients including gelatin, whey, ginger, and cod liver in ketogenic ratios.

Solutions Pet Products uses ingredients that are naturally rich in histamine-metabolizing DAO including beef kidney, pork kidney, eggs, chicken, fish, and beef meat. We ensure the nutritional adequacy of DAO-promoting Vitamin B6, copper, magnesium, and calcium. Additionally, lactobacillus probiotic strains increase DAO, as do our fermented ginger and chamomile.

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- 4) Yeasts such as *Saccharomyces cerevisiae*, *Candida utilis*, and *Kluyveromyces marxianus* have also been shown to produce glutamic acid during fermentation (5, 6, 7). *Candida utilis* has been found to produce lysine during fermentation as well (8).
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