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Dr. Anjali Gautam
Division of Surgery, Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Dr. Kumar Govil
Ph.D. Scholar, Division of Animal Nutrition, Centre for Advanced Faculty Training ICAR- Indian veterinary Research Institute Izatnagar Bareilly, Uttar Pradesh, India

Dr. Dinesh Thakur
Department of Animal Nutrition, College of Veterinary Science and A.H. Jabalpur, Madhya Pradesh, India

Dr. Adesh Kumar
Division of Animal Genetics and Breeding, Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Dr. KPS Saini
Department of LPM, College of Veterinary Science and A.H. Jabalpur, Madhya Pradesh, India

Correspondence
Dr. Kumar Govil
Ph.D. Scholar, Division of Animal Nutrition, Centre for Advanced Faculty Training ICAR- Indian veterinary Research Institute Izatnagar Bareilly, Uttar Pradesh, India

Scientific dog feeding for good health and its preparation: A review

Dr. Anjali Gautam, Dr. Kumar Govil, Dr. Dinesh Thakur, Dr. Adesh Kumar and Dr. KPS Saini

Abstract
Companion animals play an important role in our lives, providing a positive impact on the emotional and physical health, as well as strengthening the communities. Nutrition plays determining role in the overall health and well-being of pet animals. Many commercial brands are formulated using insights gained from scientific nutritional studies and there is no reliable previewed evidence that homemade foods are superior. Thus, a thorough understanding of the principles and processes in preparation of pet food in general and dog food in particular is necessary. It is imperative to evaluate whether and how the pet food system as a whole can sustainably support the health and nutrition of the growing population of companion animals. It is evident that nutritionally balanced pet food can modify gastrointestinal physiology, promote favorable changes in biochemical parameters, improve immune functions and may reduce or minimize the risk of developing heart diseases and obesity in dogs.

Keywords: Health, homemade food, biochemical, immune system, obesity, heart disease

Introduction
Companion animals play an important role in our lives, providing a positive impact on both the emotional and physical health of people with whom they have contact, as well as strengthening the communities in which we live. Physical benefits include associations of pet ownership with decreased medical expenses and visits to the doctor, increased physical activity, reduced blood pressure and risk of heart disease, and reduced risk of allergies linked to asthma in children [1]. Psychological benefits include an association of pet ownership with reduced levels of stress, lower incidence of depression associated with spousal loss, and higher self-esteem in children and adolescents [2]. Pet ownership has also been associated with increased social engagement and social cohesion. Often based on consumer demand rather than nutritional requirements, many commercial pet foods are formulated to provide nutrients in excess of current minimum recommendations, use ingredients that compete directly with the human food system, or are over consumed by pets, resulting in food wastage and obesity, which presents challenges in optimizing the sustainability of the pet food system and pet ownership [3].

To ensure that pet ownership can be sustained in the future, it needs to be affordable and culturally acceptable and must effectively satisfy the needs for good health and well-being of animals as pets. Recommendations differ on what diet is best for dogs. However, many commercial available pet foods are formulated using scientific nutritional studies [4] and there is no reliable peer reviewed studies that domestic options are superior. In general, pet food are either dry (kibble) or wet (canned). One important component of ensuring that these needs are met is appropriate nutrition. It is essential to develop the pet food system as a whole that can sustainably support the health and nutrition of the growing population of companion at present as well as in future. In this review, we describe the scientific concept pet food and propose its application to companion animal nutrition.

Meal-type animal foods, on the one hand, generally have a very high nutritional and caloric value, providing a complete and balanced diet for the animal, and excel lent storage characteristics, thus permitting the use of relatively inexpensive packaging techniques. However, the palatability of many dry meal-type animal foods is poor and, in many cases, the animal will not eat them at all in dry form, necessitating the addition of liquids prior to their consumption; liquid addition often fails to solve the palatability problem since the products become mushy or doughy and are rejected by the animal if there are any other foods available;

moreover, such reconstitution fails to bring forth the inherent initial palatability factor possessed by meat and meat by-products. Therefore, the desirable nutritional characteristics of this form of animal food may be defeated by its relatively poor palatability. In general product stabilization against microbiological spoilage is achieved in such a product by maintaining the moisture content below the critical level for vegetative growth of such organisms as yeasts, molds, and bacteria. Various types of pet foods are listed in table 1 [1, 4].

Table 1: Types of Pet food [1, 4]

Type	Description	Example
Raw pet food	• Pet food that has not undergone any heat or preservation treatment (refer to definition) • Prepared with or without added ingredients • Stored chilled or frozen	• Raw meat mince or chunks • Raw offal • Raw chicken neck • Pelletised raw meat • Raw meat patties
Canned pet food	• Retorted or aseptically processed (low-acid) • Packed in cans or pouches • Shelf-stable at ambient conditions • Typically has a moisture content of 60 to 75% or aw ≥0.85	• Canned dog food • Cat food in pouches
Heat treated refrigerated (wet) pet food	• Pasteurised • Stored chilled or frozen • Typically has a moisture content of 60 to 75% or aw ≥0.85	• Chilled dog rolls
Semi-moist pet food and treats	• Heat treated • Additional hurdle(s) is usually applied (e.g. aw control, pH control, use of preservative) • May be shelf-stable at ambient conditions if mould growth is inhibited (e.g. by vacuum packaging and/or use of anti-fungal agent) • Typically has a moisture content 25 to 35% or aw of 0.60 to 0.80	• Shelf-stable dog rolls • Shelf-stable semi-moist meat and vegetable chunks • Soft jerky
Dry pet food (kibbles) and treats	• Extruded, dried and baked • Shelf-stable at ambient conditions • Typically has a moisture content of <10% or aw of 0.25 to 0.50	• Dog biscuits • Kibble
Freeze-dried pet food	• May or may not be heat treated prior to freeze-drying • Shelf-stable at ambient conditions • Typically has a moisture content of ≤10 % or aw ≥ of 0.25 to 0.50	• Freeze-dried meat chunks
Dried pet chews and treats	• Heat treated and then dried (e.g. air-dried) • Shelf-stable at ambient conditions • Typically has a moisture content of <10% or aw of 0.25 to 0.50	• Hard jerky • Dried bone, ears, hooves, liver, • Pet chews produced from processed hides

Canned-type animal foods, on the other hand, are generally received very favorably by animals, apparently due in part to their meat-like texture, consistency and aroma. However, the elevated moisture content of such products necessitates thermal processing in sealed containers to obtain a commercially sterile product, thereby adding considerably to product cost. Furthermore, once such a can is opened, it must be quickly consumed since the product is quite conducive to supporting microbiological growth and hence will deteriorate very rapidly unless stored under refrigeration. In general, the concept of an intermediate moisture product, that is, one having a moisture content in excess of 10% and substantially below 75% has been largely overlooked. To be sure, an increase in the moisture level of many animal or pet food products will increase the palatability thereof. However, any significant elevation of the moisture level of such foods above10% leads to microbiological decomposition unless such products are packaged in a hermetically sealed container and commercially sterilized or maintained in a frozen or refrigerated state throughout the period of distribution and storage by the consumer. Such packaging or preservation methods are expensive and not convenient to the consumer under all anticipated conditions of use. In any event the concept of an intermediate moisture product for sale as animal or pet- food, i.e., a product intended for distribution at a moisture level above 10% by weight as, in the main, escaped the attention of prior art workers [4].

Nutritional Criteria of Ingredients for Pet Food Development

When the right quality ingredients are mixed in selective proportion, the desired end product can be achieved with expected and enhanced quality parameters. The enhanced quality effect of the ingredients would result in a better value added product. The nutritive feeding value of the ingredients can be improved by extrusion cooking which contributes to optimum utilization of nutrients in formulations.

A. Proteins

Protein is an essential component of dog diet, providing amino acids for the physiological states of maintenance, growth, lactation and gestation". The raw materials are selected from different sources for pet food manufacturing. Many of the plant and animal sources provide required ingredients to Pet food. Since dogs are carnivores, by-product meals, meat and poultry meals, and meat-and-bone meal are commonly used as proteinacious ingredients in pet food formulations. These sources are used as animal proteins. Quality of the animal protein sources can vary from batch to batch and hence quality of these materials was tested before utilization in pet food formulations.

Most dry foods contain a large amount of cereal grain such as com gluten meal/soybean meal which is used to boost protein percentages without expensive animal source. Generally, these meals are produced by heat treatment and their production methods involve either over, moderate or under heating. However, the extrusion cooking inactivated the antinutritive factors and therefore the extruded soybean was used in pet food formulations after confirming the inactivation levels. SDAP (serum dries animal plasma as protein source)

may influence intestinal function and thereby affect digestion. Addition of SDAP to dry dog food kibbles improved digestibility of nutrients and decreased excretion of fecal DM [5].

B. Fat

Fat is included in Pet food formulations as an energy supplement as well as palatability enhancer. However, during extrusion of Pet food and subsequent storage the fat is susceptible to oxidation resulting in poor palatability. Fat is generally considered not well for health, but is actually a very important nutritional requirement in animal diets. Fats are concentrated forms of energy, contain approximately two-and-one-fourth times the energy as an equivalent weight of protein or carbohydrates. Since fats are abundantly available in both plants and animals, they are an economical and good source of productive energy and fatty acids. Fats can also be synthesized in the body from fatty acids in the diet, from carbohydrates, and from metabolites of protein through various metabolic processes mainly in liver, which provide good source of energy during fasting and stress. Fats serve many functions includes, supply energy, enhances palatability, influence the texture, and play important role in digestion, absorption and metabolism of fat soluble vitamins. The type and quantity of fats in the diet are extremely important since they can influence appetite and food intake, the type of fat deposited in the body, and the ability to perform muscular work as well as haircoat condition. Supplementation of ω -3 PUFA significantly affects the blood lipid profile by reducing the cholesterol and HDL cholesterol in blood [6].

Essential fatty acids

Essential fatty acids are the fatty acids present that are required by the body. The three most important are linoleic, alpha-linolenic, and arachidonic. In dogs, arachidonic acid can be synthesized from linoleic acid. Cats, however, cannot synthesize arachidonic and thus it is dietary essential along with linoleic acid and alpha-linolenic. Essential fatty acids should be at least 2% of the daily caloric intake to prevent deficiencies.

C. Carbohydrate

Carbohydrates are affordable source of energy and play an important role in the composition of most commercial pet foods. Carbohydrates are less expensive and more readily available as an energy source than proteins. The amount and type of carbohydrate in pet food determines the amount of nutrient value of the food. Some animals have intolerance to carbohydrates and need to be supplemented with natural enzymes or fed a reduced carbohydrate diet. Once considered filler by the pet food, cereal and grain products now replace a considerable proportion of the meat. Among various cereals used in India rice grains having highest digestibility of nutrients in dogs [7].

Carbohydrates are also essential in the formation of dry pet food. Carbohydrate is must for preparing dry kibble but canned pet food can be prepare without carbohydrate. Starch is used generally to add structure, texture, and form to kibbled food helping to create a product that is stable as well as easy to feed. Raw cereal grains are digested much more slowly in the intestine and there are some starchy carbohydrates, including raw potatoes and bananas that are completely resistant to digestion in pets [7].

D. Fiber

Fiber is found in a variety of sources, but in dog foods, it comes primarily from the cell walls of plants and grains present in the food. Almost all carbohydrate sources will contain some fiber. Some of the most common sources of fiber in dog food include rice hulls, soybean hulls, beet pulp, bran, peanut hulls, and pectin. The lowest fecal DM and g wet feces/kg TDF intake percentage observed in dogs consuming the CB diets [8]. Fiber is not considered an essential nutrient in the diets of cats and dogs, but it is present in almost every commercial pet diet. Dogs do not derive any energy from fiber, however, improved colon health is a benefit of having fiber in the diet, and therefore, its presence in dog food is often considered beneficial.

One of the most common uses of fiber in dog foods is in the dietary management of obesity. The addition of extra fiber in the diet may be useful in reducing and preventing obesity. The fiber that is added to specialized weight loss diets helps to increase bulk and promote a feeling of satiety (fullness) without adding calories. The dog eats a satisfying meal, but consumes fewer calories and thus loses weight. It may be confusing to hear that fiber can be used for two very different problems, namely diarrhea and constipation. In addition to its water absorbing properties, the binding and gelling properties of fiber also aid in the treatment of diarrhea. Fiber plays role in alleviating the symptoms or chronic diarrhea, dysentery and several intestinal disorders [9]. Diabetes mellitus is a common metabolic disease in dogs. Feeding a high fiber diet to diabetic dogs has now become a standard part of treatment and has helped in the management of many diabetic patients.

E. Mineral supplementation in pet food

Minerals are essential nutrients needed by the body, and though they are present in natural food ingredients, supplementation of dog foods is usually required to meet the nutrient requirement standards developed by the Association of American Feed Control Officials (AAFCO) [10]. The following table lists mineral sources which are commonly found in dog foods. Foods high in each mineral are also listed.

Mineral	Mineral Supplement Sources	Food Sources
Calcium (without phosphorous)	Calcium carbonate, Limestone	Poultry by-product meal, lamb meal, fish meal
Calcium and phosphorus	Defluorinated phosphate, Dicalcium phosphate, Mono and tricalcium phosphate.	Bone meal
Phosphorus	Phosphoric acid, Sodium tripolyphosphate	Meats, eggs, milk products
Magnesium	Magnesium oxide, Magnesium sulfate	Bone meal, lamb meal, oilseed/protein supplements, wheat and oat bran, beet pulp, soymill run
Potassium	Potassium citrate, Potassium chloride, Potassium sulfate	Soybean meal, unrefined grains, sunflower hulls, rice and wheat bran, soymill run, yeast
Sodium and chloride	Sodium chloride (salt), Sodium acetate, Sodium tripolyphosphate Calcium chloride, Potassium chloride, Choline chloride	Fish, eggs, dried whey, poultry by-product meal, soy isolate
Iron	Ferrous sulfate, Ferric ammonium citrate, Ferrous	Meats, beet pulp, peanut hulls, soymill run, dicalcium

	fumarate, Ferric chloride, Ferrous carbonate, Ferric oxide, Ferrous oxide	phosphate*
Copper	Cupric carbonate, Cupric chloride, Cupric hydroxide, Cupric oxide Cupric sulfate	Meat, especially liver
Manganese	Manganese carbonate, Manganous chloride, Manganous oxide Manganese sulfate, Manganous sulfate	Sources of fiber, dicalcium phosphate*
Zinc	Zinc carbonate, Zinc chloride, Zinc oxide, Zinc sulfate	Meats, sources of fiber, dicalcium phosphate*
Iodine	Calcium iodate, Potassium iodide, Cuprous iodide, Iodized salt	Fish, eggs, iodized salt, poultry by-products
Selenium	Sodium selenite, Sodium selenate	

F. Antioxidant in pet foods

Antioxidants are substances that help to keep fats and fat-soluble ingredients (including vitamins A and E) from becoming oxidized. Once a fat is oxidized, it starts to taste rancid and loses much of its nutritional value. Dog and cat foods, which often contain significant levels of fat, are especially susceptible to oxidation. Canned foods are protected because they are airtight, but dry foods need to have antioxidants added to preserve them. If an antioxidant is used, the Association of American Feed Control Officials (AAFCO) guidelines require that the common name of the antioxidant must appear on the label, along with a reference to the fact that it is being used as a preservative. There are both natural and artificial antioxidants, and they all work to preserve food from oxidation. The most common artificial antioxidants used in the pet food industry are ethoxyquin, butylated hydroxytoluene (BHT), and butylated hydroxyanisole (BHA). Commonly used natural antioxidants include tocopherols (vitamin E), ascorbic acid (vitamin C), citric acid, and rosemary. Oral supplementation with Vitamin E increased sperm motility, vigor and concentration and decreased the percentage of major sperm defects as well as it reduces the deleterious effect on the spermiogram and on the seminal plasma lipid peroxidation in dog [11].

Natural antioxidants

Some consumers prefer pet foods with only natural preservatives. Vitamin E, vitamin C, citric acid, and rosemary are among the most commonly used natural antioxidants. Mixed tocopherols are a common source of vitamin E in pet foods. Vitamin C is provided by ingredients such as cranberries, blueberries, apples, and some other fruits. Citric acid is also found in many of these, especially citrus fruits. Dietary lutein stimulated both cell-mediated and humoral immune responses in the domestic canine [12].

Pet food Specifications:

Table 1: Maintenance diet specifications for adult dog

Constituent %	Specification	
	BIS (1986) [13]	AAFCO (2001)
Moisture	10.00	10.00
Crude protein	24.00	22.00
Crude fat	05.00	08.00
Crude fibre	05.00	04.00

Table 2: Pet food specification for different growth stages [14].

Species and Growth Stage	Recommended Protein (%)	Recommended Fat (%)
Puppy	28	17
Adult dog	18	9-15
Performance dog	25	2
Racing sled dog	35	50
Lactating dog	28	17

Ingredients for pet food: Following are guidelines for feeding a raw or cooked home-prepared diet to healthy dogs. No single type of food, such as chicken, should ever make up more than half the diet. Homemade food for dogs can be fed either raw or cooked. Leftovers from your table can be included as long as they're foods you would eat yourself, not fatty scraps. Ground wheat and rice were incorporated as starch additives, rice bran as source of fibre, soybean, poultry byproduct meal and corn gluten meal as protein sources and fat as energy and for palatability. Mixing was done in a mixer separately for all the formulations by transferring all the relevant ingredients into the paddle mixer. The formulated mix can be extruded as pellets as. During extrusion, similar process conditions were maintained for all pet food formulations containing raw soybean and extruded soybean. Though raw soybean was co-extruded with other ingredients, the inactivation will not be effective as the friction, pressure and temperature generated may not rupture the cells of soybean particles during extrusion due to interference from the other ingredients present in the pet food formula. Most commonly feed ingredients fall under falling categories:

1. Grain Byproducts: Rice grain wheat grain, oat meal, barley etc.
2. Animal products: Meat and meat products, raw meat, bone meal, offal's etc.
3. Plant products (other than cereal based): fruits nd vegetable, starchy vegetables.
4. Other ingredients: Egg, milk products, mineral and vitamin supplements etc

Pet Food Preparation

Methods to prepare the pet foods for different kind of pet food namely, dry food, semi-moist food and canned food is described below:

A. Dry food production process

There are many ways to make kibble but the most common method is extrusion. It's a process that was created to manufacture breakfast cereal in the 1950s. Regardless of the food you choose, every brand of pet food sold in the market has to meet the guidelines of the Association of American Feed Control Officials (AAFCO), in addition to the requirements of the USDA and the FDA. AAFCO (2001) guidelines require that the ingredients meet all of a pet's nutritional needs and its preparation mostly consist of below mentioned steps [15]:

1. Raw Materials

Regardless of the company it all starts with the raw materials. There are dry ingredients (chicken meal, beef meal, wheat, corn, rice, etc.) and wet ingredients (fat). The raw materials are stored in large bins (dry) and tanks (liquid). Special ingredients like vitamins and minerals are delivered in bags. The ingredients in products come from animals that are considered suitable for human consumption. When the raw materials reaches a manufacturing plant sample is taken and

tested to be sure quality meets their standard.

2. Mixing and grinding the ingredients

At this point, the correct amounts of each ingredient based on the food they're making at that time are weighed and mixed properly. The right ingredients in the correct proportions are combined. Then that mixture will go to a hammer mill where it will be ground. All manufacturers grind their ingredients and most will use a commercial hammer mill. The consistency, usually like course flour, is really important. It ensures a smooth kibble surface and good kibble shape. It's also important in the cooking process and for water absorption. After grinding, mix the meal again to ensure that all ingredients are equally distributed and every bag of the end product will be of the same quality.

3. Preconditioning and extrusion

The dry ingredients and the wet ingredients come together in a mixer and they become moist dough. Then the dough moves into the preconditioner section where the dough is heated to more than 200 degrees. This causes the starch in the dough to gelatinize. It becomes more soluble so that it can absorb more water and be more easily digested. Starch is the ingredient in most dry foods that binds the final product together and forms kibble. But starch can be hard to digest so preconditioning is crucial.

Then the cooking phase begins in the extruder. The dough is cooked under high pressure and intense heat as it moves towards the open end of the extruder. During this step in the process, any potentially difficult to digest ingredients expand under high temperature and pressure, and become easier for your pet to absorb. At the end of the extruder, the hot dough passes through a shaping die and is cut into kibbles.

4. Drying

Since steam is added during the preconditioning phase, the kibbles contain a high percentage of moisture. Kibbles travel through different levels of the batch dryer until they reach a moisture level of 10%. Mold and bacteria can't grow at this level, which makes the food shelf stable.

5. Vacuum Coater and Cooling

At this point, most manufacturers will let the kibble cool and then pass it through a machine that sprays a flavor coating on the kibble. This makes it taste better and adds fat, which is very important in your pet's diet. Some pet food manufacturers instead of spraying the kibble, they use a vacuum coater. It gives their food a higher percentage of fat and greater palatability than pet foods that use a sprayer. After the kibbles cool, they go into the vacuum coater where an air pump creates a vacuum. This vacuum opens up the fine pores of the kibble, while the kibble is kept in constant motion.

When the fat is sprayed, it's evenly distributed over all the kibble. Then the pressure is increased in the coater, which pushes the fat into the fine pores of the kibble. The fat is not only on the outside of the kibble, as it would be if it was just sprayed on, but it's evenly distributed throughout the kibble.

The next step in the process is to coat the kibbles with a smell and taste enhancer, giving it a natural animal smell. And then the food is packaged.

B. Semi-moist food production process

Semi-moist food has moisture content somewhere between canned food and dry. The manufacturing process is very similar to dry food, the difference being the temperature and pressure in the extruder, which is not as high as dry food. And instead of the food going through the drying process when it leaves the extruder, it goes into coating drums that add water and chemicals to help maintain moisture. Then it's refrigerated to lock in the moisture content and keep its spongy texture. Because semi-moist food has a higher moisture content than dry food, it's more likely to spoil from mold and bacteria. It's also more likely to dry out and fall apart. So manufacturers add mold and bacteria inhibitors to their recipes, and package the food in moisture-proof bags.

C. Canned food production process

The meat product is ground into small pieces. Vitamins, minerals, and any grains in the formula get added. And all ingredients go into a mixer where they're blended. In the mixer, the temperature is increased to gelatinize the starch. While the food is still hot, it is moved into the filler/steamer machine. As the lid goes on the can, steam is blown over the top of the food so that it will be vacuum-sealed when it cools. This prevents the food from spoiling. The cans are then sterilized, which kills all the dangerous bacteria that could enter the can like botulism. When the cans are cool, they're ready to be labeled and sold. Whether you choose to feed your pet a dry, semi-moist or canned food is a decision based on your pet's nutritional needs, and in many instances convenience.

Preparation of some basic pet foods

Preparation of baked cookie

The invention of Roland *et al* (1964) [16], provides a new concept in the continuous production of cookies in which a cookie formulation comprising dry dough granules is deposited on to a pan, conveyor or oven band, preferably in loose particulate form, to form an unbaked cookie bed, there being little adherence between the various particles comprising the formulation and little densification or compaction thereof. In the preferred mode of practice, the cookie formulation is deposited on a moving oven band. The ingredients constituting the cookie formulation can be premixed prior to deposition on the moving band, or mixed concurrently with deposition on the baking band, or the dough particles can be deposited first and other ingredients layered over it. If desired, the dough particles can be arranged in spaced parallel rows with favoring and/or coloring particles filling the spaces. The thickness of the unbaked cookie bed will depend on the rate of deposition and the relative rate of movement between the cookie particle dispenser and the oven band. This invention relates to improvements in the art of baking, and more particularly relates to novel baking mixtures and baked food products, and novel means for preparing such baking mixtures and food products.

Preparation of coated pet food

As per the invention of Corbett *et al*. (1985) [17] dry pet food product can be prepared, and process having excellent palatability and nutritional value for the animal, and presenting to the consumer a desirable sheen on its surface. Two coatings applied over a primarily farinaceous core provide a textured, highly palatable product for the animal, and. a sheen is imparted independent of the formulation of the proteinaceous material covering the core. With this invention, a dry pet food that is palatable and highly nutritional for the animal and of a desirable sheen for the consumer may be consistently prepared at low cost on a commercial scale.

In accordance with the invention, the pet food product

comprises a primarily farinaceous core of desire shape covered with a primary coating including proteinaceous materials, and a secondary coating including an ingredient which imparts a desirable sheen to the final product. In a preferred embodiment of the invention, the core comprises a mixture of ground wheat and meat and bone meal, with nutrients and flavorings added. The primary coating comprises a mixture of oat groat to provide a surface texture, beef or liver for flavor, and colorants and additional flavoring agents. The secondary coating, which provides the desirable surface sheen, includes starch or egg and a colorant. The final product is prepared by mixing and shaping the core, and applying the primary coating and then the secondary coating to the core. In a preferred process, the core ingredients are mixed with water and shaped into the form of a dog bone about 2-4 inches in length, and the ingredients of the primary coating mixed with water are applied to the core by enrobing immediately before the core enters a baking oven. As the cooked core and primary coating emerge from the baking oven, the secondary coating is applied as a water-based spray, and the final product is air or oven dried. It is appreciated that the foregoing process of pet food represents an advance in dried pet food products. With this invention, a nutritious, palatable product having a desirable surface sheen may be prepared on a commercial basis with minimal variation in content and appearance from batch to batch. Other features and advantages of the present invention will become apparent from the following more detailed description [17].

Preparation of semi moist pet food Semi-moist dog are precooked in a liquid medium and thereafter cooked in the presence of water absorbing agents which results in semi-moist products which are stable to microbial attack. In this first, precooking meat in the frozen state and thereafter finally cooking it in the presence of acids and gelatinizing thickening agents. During the cooking steps, the meat product is in a semi moist solid gelatinized form. The meat product made by this process is in the form of a gel which is formed into patties or other formed particles. The present invention avoids the use of gel thickening agents, and while precooking the meat product, it is in a fluid or liquid consistency [18].

In the process of this present invention sufficient water is added during the cooking steps to provide a final product having moisture content in the range of about 38 to 52% water by weight. This admixture is cooked for approximately 15 minutes in the range of about 200° F. Under the acidic conditions of the initial cooking step, the admixture is of a soupy consistency and results in effectively destroying bacteria. After the initial cook has been completed soy flour such as texturized soy protein may be added, together with other water absorbents such as dried beet pulp, soy bean hulls, peanut hulls, rice hulls, wheat fibers and the like. These dry materials substantially absorb the water from the soupy mixture and the product takes on the appearance of a semi-moist solid product. Cooking at the 200° F. level is continued for another 15 minutes after which time the product is cooled. The final product appears relatively dry but contains approximately 40—50% water. It is loose and crumbly; it does not have a gelled consistency. Neither thickening agents nor gelling agents are added to the product. At the end of the second cooking period the product is cooled to between about room temperature at 85° F., delumped if necessary, and packaged in moisture-proof containers. The product may then be stored at room temperature; it is not susceptible to bacterial or other microorganism attack [18].

Preparation of pet chews

These are microbiologically stable, substantially neutral, nutritionally balanced, semi-plastic non-pasteurized, uncooked animal food composition of consists essentially of (l) a dried proteinaceous food substance, (2) an aqueous matrix including a water soluble colloidal binding and gelling agent (i.e., gelatin or water soluble gum), and (3) a water soluble, low molecular weight solid, liquid or mixture thereof in an amount sufficient to increase the osmotic pressure of the water in which it is dissolved thereby providing a bacteriostatic effect. The moisture content of the food composition ranges from about 15 percent to not greater than 25 percent. The amount of the gum or gelatin ranges from about i to about 10 percent by weight. The process for preparing the animal food composition involves blending a premix of the solids with a proportional amount of a pre-mix of the liquid with high-speed agitation.

Dogs like the flavor provided by the citric acid. Acidulants are used in processed food products as an aid in sterilization. Sterilization of canned food products, in particular, depends on the thermal kill efficiency of the heat applied in retorts and other processing equipment. Many bacteria are highly resistant to heat and in some instances revert to a spore form which can survive high temperatures for a long period of time. Incomplete sterilization can result in instances of botulism or food spoilage. Bacteria and other deleterious microorganisms are more susceptible to thermal kill in a low pH environment. So acidification to lower the pH to a safe level is often used. Many food products, which formerly could not have been adequately sterilized, are now safely processed and maintained for long periods of time through the technique of acidification. This can be prepared from ingredients like ground wheat, water, beef, soybean meal, propylene glycol (a preservative), pregelatinized wheat flour, animal fat preserved with BHA, dried whole egg, vitamin and mineral supplementation [12, 18].

Retort stable pet food preparation

Many owners derive pleasure from feeding their pets foods which contain shaped food pieces which the owner identifies with the particular type of pet. An example of this would be a bone shaped food piece in a dog food. Of course, these shaped food pieces must also contribute to satisfying the nutritional requirements for the particular pet. To accomplish this, the shaped pieces are preferably prepared from proteinaceous and farinaceous material [19]. The term proteinaceous material refers to glutens such as wheat gluten, corn gluten, rice gluten, and other types of cereal grain glutens known to those skilled in the art; proteinaceous material obtained from other sources such as defatted oil seed protein material; dried eggs; whole corn; wheat germ meal; dehulled soy meal; meat and bone meal; and other nown proteinaceous sources. The term farinaceous material refers to cereal flours such as wheat flour, corn flour, rice flour, oat flour, and other types of cereal flours known to those skilled in the art; ground hard wheat; ground whole corn; and other types of ground cereal-based grain material. One problem in preparing such extruded, shaped pieces is that many pet foods have to undergo the extreme processing conditions of a retort sterilization procedure. For certain shaped proteinaceous materials, such as meat analogs, this is not a concern. These meat analogs retain their analog properties even when subjected to a retort operation. However, these meat analogs are structurally different than the shaped pieces of the present invention in that they are typically prepared from texturized vegetable

protein (TVP) and may have a striated texture. By "striated texture" it is meant that the shaped piece tends to have a texture analogous to muscle striations. This striated texture allows the shaped piece to be easily torn apart along the striations, and as such the piece does not have to maintain a distinct and definite shape when subjected to a retort operation.

The extruded shaped pieces of the present invention do not have such a striated texture, however, but instead are, for the most part, cohesive. Until now, extruded shaped pieces having a cohesive texture like those of the present invention could not withstand the extreme conditions of a retort operation, but would typically dissolve when retorted. This would be undesirable since the shaped piece would not maintain its original shape and form, but would be unrecognizable. Thus, shaped food pieces having the cohesive consistency of the shaped pieces of the present invention are useful only when they are retort-stable, i.e, do not dissolve upon hydration and/or retorting, but maintain their desired shape.

Enhancing the flavor of pet food

1. According to invention of Bourdeau and white (1981) [20], by incorporating an effective amount of a palatability enhancing material selected from the group consisting of L-proline, L-cysteine, L-histidine, L-lysine, inosine 5'-triphosphate (ITP), inosine 5'-diphosphate (IDP), and adenosine 5'-triphosphate (ATP), or a combination of these, into the dog food formulation. Significant palatability boosts can be obtained by feeding dog foods improved by these palatability enhancers to dogs.
2. According to invention of Spradlin *et al*. [21], it is disclosed that an enzyme trypsin, bromelain, pepsin, and papain produces a reaction mixture which, when combined with the other ingredients of a dog food, increases the overall palatability of the food. It is also known that various sugars improve the palatability of dog foods. The starch content of a solid dog food is at least partially enzymatically converted to glucose by alpha-amylase and amyloglucosidase directly. It was found that the combination of these two enzymes permitted the reaction to occur without adversely affecting the solid character of the dog food.

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