

## REVIEW ARTICLE

### RAW INGREDIENTS IN CAT FOOD MANUFACTURING: PALATABILITY, DIGESTIBILITY AND HALAL ISSUES IN MALAYSIA

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**Abstract:** Raw ingredients commonly used in the cat food manufacturing are derived from various sources such as meat, meat by products, fish, poultry, vegetables, vegetables by products, cereals, fruits, and bones. Meat meal and meat bone meal are unpopular raw ingredients since they are manufactured from carcasses and offal of cows, pigs, goats and sheep and may even contain deleterious and unhealthy ingredients. There is the possibility of the occurrence of ingredients containing non halal components. There are several types of cat food in the market which are graded based on their ingredients and nutritive values especially the protein content. The biological values of the popular protein sources used in cat food manufacturing were highlighted. The importance of carbohydrate content, which is mostly not available on the packaging pack is emphasized and the method of calculation shown.

**KEYWORDS:** *Cat food, Raw Feed ingredients, Manufacturing, Palatability, Digestibility, Halal.*

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#### Introduction

The common list of raw materials used in the cat food manufacturing industry are: named meat, animal digest, named animal digest, named animal meal, poultry meat meal, named animal by-product meal, poultry by-product meal, meat meal, meat bone meals, bone meals, corn, corn gluten meal, wheat, oats, tapioca, potatoes, soya bean, soya bean meal, beet root, rice, rice bran, vegetables, fruits and nuts, preservatives, animal fat and oil, vegetable fat and oil, anti-rancid, vitamins and minerals, enzyme hydrolysates, artificial colourings (Martin, 1997, Anonymous, 2007, Dan, 2010, Peterson 2011a, Anonymous, 2012a, Pierson, 2012, Syufy, 2012a,b).

Raw materials used in the cat food manufacturing must be of specified grain mesh size in order to produce kibbles of right texture, structure and consistency. All these factors will one way or another influence the cat food palatability and digestibility. Most of these ingredients are imported. The raw materials can be sourced from Australia, America, and Germany, Scandinavian countries, China, Thailand, Indonesia and some African nations. Most of the raw ingredients available in the market are of animal and poultry feed quality, therefore, care had to be taken when sourcing raw ingredients for pet food manufacturing. The definition by the Association of American Feed Control Officials (AAFCO) regarding protein source is non-restrictive in the pet food and livestock feed manufacturing industry, which may range from anything except proteinases. The use of rendered companion animals for meat meal, tankage and digest are not restricted. Cat food ingredients are also derived from unhealthy sources such as animals killed in accident and from culled zoo animals

(Martin, 1997). In some instances, animals euthanized with chemical agents such as sodium pentobarbital are used as ingredients in cat food. This drug should not be used on animals intended for food production, for both human and animal (Martin, 1997) and prohibited as stated in 1993 Report of the American Veterinary Medical Association Panel on Euthanasia.

According to Martin (1997), the dead animals with their fur intact and along with their collars, tags, flea collars and even with their wrapped plastic bags, were then cooked at 115°C for 20 minutes, together with viscera, bones and fats. Protein meals produced from such animals with their accessories included are widely used in the manufacturing of pet food, and these practices were unknown to many pet owners worldwide. Helman (2008) noted that scrap beef products gathered from the slaughter house floor were mushed up and treated with ammonium hydroxide (to kill *Escherichia coli* and *Salmonella*) and made their way for pet-food manufacturing and some were even used as add-on to meat in the fast food franchisee in the United States.

The term 'meal' denotes the basic materials are not fresh but were heated at extreme temperatures of 121°C-126°C (Anonymous, 1990, 2009). This extreme heating process led to the excretion of fat (grease/tallow), which raises to the surface and is skimmed off and later used to spray to the kibble products to improve palatability. The remaining solids are then compressed to remove the residual liquid, ground to the required mesh size and air dried to the prescribed moisture level. The used of extreme temperature may have destroyed most nutrients and alter the structure of the amino acids which rendered unavailable to the tissue due to poor absorption (Cline, 2011).

### ***Halal Food Product Issues in Malaysia***

Currently, the procedures undertaken by the Malaysian government pertaining to halal human food products are very stringent, where each State Government in Malaysia had their own religious departments to monitor and address halal issues. In addition, we had the Department of Islamic Development Office of the Prime Minister (JAKIM), which is the controller and authority of Halal Certification in Malaysia. This government body and those of the state religious department had the authority to issue Halal Certificates to those who qualify to produce and market halal products and also those who operate halal food premises. Food manufacturers and food restaurant operators are only allowed to use the halal logo on the packaging of their products and to display the halal logo at their restaurant premises if they met all the basic requirements set by JAKIM.

It is prerequisite to produce and market halal pet food products, especially for the Muslim's market, where handling of non-halal products especially those containing animal residues derived from pigs is considered 'haram'. Furthermore, animal feed must be prepared from halal meat meal sources, halal enzyme derivatives, halal protein based enhancer/flavour and even water for processing must be from known and purified sources. The major supply of raw materials for animal and livestock feeds are mainly undertaken by the Western nations and those from the Far East. These countries are noted to have considerable population of cows and hogs, where a totally 37 million and 100 million were respectively slaughter annually (Anonymous, 2007). In addition, most of the population of cows slaughter were not according to the Muslim ritual procedures and furthermore these nations had low population of goats as another meat meal source.

Non-halal issues of imported animal feed is not new in Malaysia. DNAs of non halal animal feed meals have been detected in many imported animal feed products, but this issue had been resolved quietly to prevent public outcry. Therefore, it is timely for pet food to be made from halal based raw materials and Malaysia should lead the way in manufacturing these products and also producing halal raw materials for animal and livestock feeds.

Furthermore, Malaysia had been identified as one of the leadings halal food hubs in the world. The same stringent procedure should be applied to those importing raw materials for any animal feed production in Malaysia in order to ensure and to maintain that our products are truly halal and widely recognised and certified by the Muslim nations world-wide.

**Protein Types & Their Grading**

Protein is the very essence of cat’s growth, where it is required to maintain the total structure of this animal, which comprises of: muscle, bone, ligaments and tendons. The functional components of the body, including enzymes, plasma, hormones and neuro-transmitter are all protein based (Peterson, 2011a, b)

Protein is the source of amino acids, and cats require 22 types of amino acids but 11 can be synthesised by the liver from carbon and nitrogen, termed as dispensable amino acids/non-essentials (Foster and Smith, 2012a,b, Anonymous, 2012b). The remaining eleven (11) are categorised as indispensable/essentials amino acids in the cat’s diet, including taurine since they cannot be synthesised in sufficient amounts or cannot be synthesised at all (Cline, 2011, Anonymous, 2012c). Two of the essentials amino acids namely ‘phenylalanine and methionine’, can be derived through dispensable amino acids which are tyrosine and cysteine, respectively (Peterson 2011a).

Table 1 illustrated the 11 types of essentials amino acids and their minimal requirement for growth and reproduction and adult maintenance of the cats (Contreras, 2004, Peterson 2011a, Foster and Smith, 2012a, b).

Natural cat food should carry a minimal protein content of 50%-70% (Peterson, 2011b). Others estimated cat protein requirement to be between 50% and 60% (Zoran, 2002, Myrcha and Pinowski 1970, Vonduruska, 1987, Crissey *et al.* 1999), since cat is an obligate carnivore, where the main diet is protein domination (Peterson, 2011b). AAFCO in 2006 had set a minimal dietary level of 26% of protein content as acceptance to maintain the cat’s health and vitality but many veterinarians insisted that the minimal value should be 35-45% for adult cats and more for kittens, the sick and the injured (Anonymous, 2012d). According to Anonymous (2012e), a diet less than 19% protein can cause deficiency in amino acids (the structural units of protein) and sickness, and a diet of between 19% and 25 % may cause over eating as the cat tries to obtain the necessary nutrition, resulting in obesity.

Table 1: AAFCO Nutrient Profile of Essential Protein Source of Amino Acids for Cat Food. (Adapted from The nutrient Profiles for Cats, AAFCO, Official Publication, Cited in Anonymous, 2012c)

Nutrients	Growth & Reproduction Minimum (%)	Adult Maintenance Minimum (%)	Maximum
Arginine	1.25	1.04	-
Histidine	0.31	0.31	-
Isoleucine	0.52	0.52	-
Leucine	1.25	1.25	-
Lysine	1.20	0.83	-
Methionine	0.62	0.62	1.50
Phenylalanine	0.42	0.42	-
Threonine	0.73	0.73	-

Trytophan	0.25	0.16	-
Valine	9.0	9.0	-
Taurine Extruded	0.10	0.10	-
Taurine (Canned)	0.20	0.20	-

The above values are based on percentage of crude protein (CP). The minimum requirements for growth and reproduction and adult maintenance are 30% and 20% based on dry matter basis, respectively.

The range of crude protein (CP) content in the commercial cat food sold in Malaysia can be as low as 26%, but 28-32% is common and the super-premium quality which may contain 35 to 45%, rarely above 50% and none exceeding 55% (ACISB, 2012). There is no dried cat food in the market that can emulate or come close to wildcats diet in the wild comprise of: 50-70% protein, 30-40% fat and 5-10% carbohydrate (Peterson, 2011b).

However, to achieve this adequate nutrient status, it will make the commercial dried cat food very expensive which may not be affordable by many potential buyers. In addition, the market will be highly niche and not feasible commercially. This may be the main reason why very few attempted to produce such product for the commercial market. Canned cat food of this composition is available in the market under ‘The 95% Rule’ where a cat food may not be labelled ‘Chicken for cats’ or ‘Chicken Cat Food’ unless it contains 95% or more chicken by total weight of the product (Syufy, 2012c) and will surely be very expensive for the consumers.

Crude protein means total amount of nitrogen within the product, which may include from the animal protein, non-animal protein (from grains) and from non-protein nitrogen (NPN) sources (Hotchner, 2011), where malpractices of importers and Chinese producers of melamine ‘enhanced’ vegetable proteins were widely reported to contaminate the pet food industry (Syufy, 2012d). Janine (2011), pointed out that ‘crude protein’ is a measure of total nitrogen content of a product, and from that, give rise to the amount of protein within that product. The CP will therefore comprise of non-protein sources that originate from molecules such as from urea, creatine and nitrogen from the protein as well (Janine, 2011) and ground feathers, which is non-digestible protein (Rae and Mark, 2009).

It is common for the buyer to think that the word ‘crude protein’ to mean animal protein content in the cat food, which is totally misleading. The source can be from meaty material to carcasses to internal organs, animal by-product and other waste from the slaughter houses unfit for human consumption and those from selected vegetable protein grains and chemical based urea. It is extremely important to choose real whole meat (named meat) as primary ingredient such as chicken, lamb, salmon, and turkey. The proportion used is of significant importance as compared to the grains composition, and other added forms of protein sources defined in the formulation.

The availability of birds’ feather based protein in the market is very rampant, those claimed as being prepared using hydroxylation processes and sold openly by big corporation company in the west as fit for animal feed consumption but not for pets. The material will remain to be as creatine origin and its digestibility and palatability by cats and dogs is doubted.

There are also those cunning feed mill manufacturers, who may add ground feathers to boast the protein content of the feed meal, but this is an indigestible protein source and will not be beneficial to the cat and may even damage the cats’ kidney. Similarly, for those using melamine (non-protein nitrogen source) to manipulate the protein content, which is hazardous

to the kidney, where melamine was widely reported to be added to infant's milk production in China, in 2009, resulting in infants' death due to kidney failures.

It is important for the buyers to understand the very few basic terms used in the packaging label in order to differentiate and understand the true content of the cat-food composition (Syufy 2012a), where protein is the most expensive ingredient in the pet-food (Hotchner, 2011). Syufy (2012a, b, c) outlined clearly the basic nutritional needs of cats and offered some very basic tips on how to select the right cat food for your cat. Protein can be of low quality and high quality, where the former is much difficult for the liver to process than the latter. Low quality protein are less digestible compared to high quality protein, and resulting in less absorption and the pet had to consume more in order to get that enough protein. Poor quality cat-food may put tremendous strain on the pet's kidney, where it has to cope up with extra load of waste to filter and may affect the pet's health in the long run.

Low priced and some medium priced pet food contain cheap protein source and the reverse is true for expensive priced pet food. The best indicator to refer to when purchasing cat food is the price tag. Cheap protein are derived from the following animal protein sources, arranging in descending order: Turkey by product meal, chicken by product meal, poultry by product meal, meat meal, meat and bone meal, meat meal by products, bone meal. Another source of cheap proteins are from vegetables, but their biological values i.e. the capability to supply amino acids are very low. In addition, they are least digestible and unsuitable for pet food manufacturing.

For the production of medium range priced cat food, the choice of protein are as follows and they are arranged in the descending order to reflect their pricing and their preferential use by the manufacturer: Lamb meal, turkey meal, poultry meat meal, chicken meal, fish meal, meat meal. It is very interesting to note that fish meal is amongst the last choice for pet food manufacturing because it contains high ash content (19%), which is highly undesirable but high in fat content (8-12%), rich in Omega-3 fatty acid and is highly digestible than meat source ingredients *per se* (Dan, 2010). It is often used in combination with meaty meals or named meat ingredients.

Meat meal and meat bone meal are unpopular, derived from cows, pigs, goats and sheep (Anonymous, 2007) since sheep and goats are rarely available compared to 37 million cows and 100 million pigs were slaughtered annually, and nearly all meat-by-products come from cattle and pigs, and may even contain unhealthy raw ingredients (Martin, 1997). Meat meal, meat bone meal, meat by-product meal of western origin, including China and those from African nation may contain pig residues, which is non-halal to Muslims and handling them is prohibited.

High quality, super premium dried pet food are manufactured using named meat (without feather, head, feet and intestine) and human grade named meat source, and non-rendered. Some manufactures even claimed that their meat sources are from free range, named fish, either from the sea or the wild. Our experiences revealed that, named dehydrated named meat being used to manufacture high grade kibbles pet food

In addition, there are other named meat sources, being used in the canned pet-food preparation. These named meats are slaughtered, the human-grade parts are removed for sales and those leftovers such as clean flesh and skin from the carcasses (classified unfit for human consumption) were grinded for the above used. Bones may or may not be included and the carcasses can be whole, partial or combination of both. They must be free from feathers, heads, feet, intestine, offal, hooves, skin, hair, horns, blood, and hide trimmings (Dan, 2010).

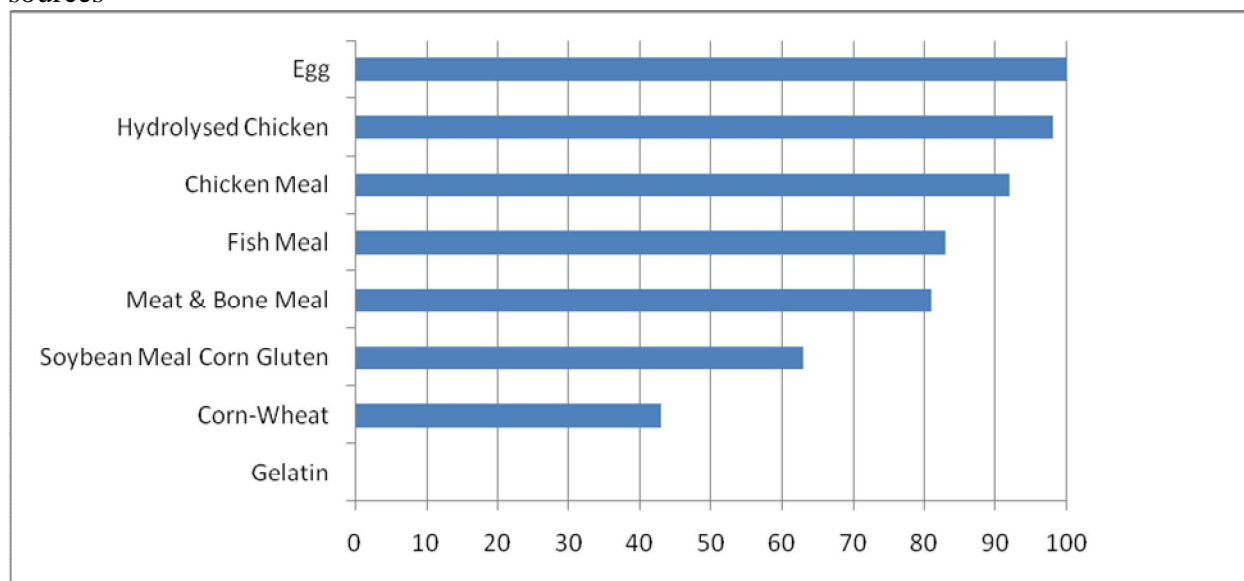
The seller must make known to the buyer whether the bones are included or excluded in the named meat when putting up for sale. This named meat source, without the bones are also being used to make high quality pet food, but of lower grade than the human grade meat

source. However, the availability of this boneless named meat meal in the market is very limited due to limited meat supply, and it is common to get named meat meal with bones included, due to the fact that carcasses are of abundance supply.

As illustrated in Table 2, the protein biological values for the common petfood ingredients vary drastically. ‘Biological value’ describes how efficiently the protein is used (Anonymous, 2012c) or a measure of protein ability to supply amino acids (Peterson 2011a). Biological value of plant protein is lower compared to animal based protein and the former is less digestible compared to the latter, respectively. In addition, plant protein contains less of the 11 essential amino acids and some are totally absent (Peterson 2011a).

This is the main reason why grain-based proteins, such as soya-bean meal, corn gluten meal and corn meal should not be the primary source of protein in pet food preparation, and should be totally avoided in old cats’ diets (10 years and more). Protein content in the petfood is a function of the ‘digestibility factor of the biological protein value’ of each ingredients used in the pet food preparation. According to Anonymous (2012c), the digestibility of petfood is about 80% for kibbles, 85% for semi-moist and canned foods containing high proportion of cereal grains and more than 90% for canned diets with meat as the primary source of protein.

Table 2: Comparative Percentages (%) of Protein Biological Value (PBV) between different sources



(Source: Peterson, 2011a)

**Fats Sources and Grading**

Dietary cat food composition of fat is mainly derived from land and marine animals and seed oils of numerous plants (NRC, 2006) and renowned to provide twice the amount of energy compared to protein and carbohydrate per gm. Fat provides 8.5g calories of energy/gm., while protein and carbohydrate contribute 3.5 calorie of energy/g each (AAFCO,2000) This may explain why cat is carnivorous and rely on protein and fat for their energy sources and may not require carbohydrate at all in their diet.

Fats had been classified into a broader groups of compounds identified as lipids that can be either glycerol or non-glycerol based. Glycerol can be of simple lipids such as triglycerides and compound lipids of phospholipids and glycolipids (NRC, 2006). Non-

glycerol based lipids are cholesterol and its fatty acids esters and this category includes waxes cerebrosides, terpenes, spingomyelins and various sterols (NRC, 2006).

In addition, hydrogenation of fats and oils (addition of hydrogen atoms to the carbon-carbon double bond) reduces the degree of unsaturation, causing the melting point to increase, thus reducing the susceptibility of these oils to oxidative deterioration (NRC, 2006). The feeding of these trans-fatty acids to human and animals in relation to health consequences have been extensively reviewed by Mensink and Katan (1990) and Emken, (1991), with the possibility of modifying the lipoprotein metabolism. The other sources of dietary fats in the cat food can be derived from eggs, muscle and offal.

Polyunsaturated fatty acids (PUFA) are highly susceptible to oxidation, where the main source shall be fish oil, especially redfish (56.4%) and herrings (52.7%), and vegetable based oil, popularly used in cat food manufacturing such as safflower (74.5%), corn (66%), soya-bean (58%), cottonseed (52%), sunflower (40%), and canola (30%) palm oil, (9.3%), palm kernel (2.3%) coconut oil (2%) (NRC, 2006). Using these oils high in PUFA, the diet cat food may need to be supplemented with Vitamin E to prevent oxidation, and rendered the fats unavailable for uptake. The minimal set limit for vitamin E is at 30 IU/kg dry matter and with dietary levels expected to increase, the needs to increase the vitamin E concentration in the cat food is inevitable (NRC, 2006). AAFCO (2000) suggested that of every 10 IU of vitamin E for every gm. of fish oil/kg diet and similarly is expected for other diet rich in PUFA sources.

It is interesting to note that, coconut oil, palm kernel oil, crude palm oil are absolutely rich in saturated fats of 87%, 82% and 49%, respectively (NRC, 2006). While those of corn, soya bean canola and safflower oils have less than 15% saturated fats. According to Anonymous (2012f), the saturated fat is main cause of high serum cholesterol and cardiovascular diseases in human when consumed in excess. Scott (1968) noted that coconut oil is unpalatable and failed to support cats' growth. Preference for beef tallow over butter and chicken fats but no preference were noted between beef tallow, lard or partially hydrogenated vegetable oils among cats (Kane *et. al*, 1981).

Generally, high fat diets appear to be highly palatable to cats than low fat diets (Greaves, 1965, Kendall, 1984, NRC, 1986). However, they exhibited preference for 25% total fat diet compared to that of 10% or 50% total fat diet. Animal and vegetable fats had been widely used to enhance pet food palatability by spraying on to the kibble surface. To further increase the cat food palatability, kibbles were further sprayed with protein hydrolysates, meat extracts and digest, which contain amino acids, peptides and fatty acids in viscous form, and the latter had been reported to improve palatability of cat food by two to threefold over uncoated product (Anonymous, 2012c).

Crude fat content of commercially dried cat food may contain between 8 and 13% on dry matter basis. However, some of the premium and super premium products may contain from 18 to 20%, while canned cat food may contain between 12% and 24% fat on dry matter basis (ACISB, 2012). Based on the 'ether extracts (the method adopted for fat content determinant of food) indicated that apparent digestibility of cat food is 96% for canned foods, 92% for semi-moist foods, and 79% for dry foods (Anonymous, 2012c).

### ***Carbohydrates Classification and Grading***

Nantel (1999) classified carbohydrate based on degree of polymerization and digestibility; and they are classified into four groups, namely: absorbable (monosaccharides), digestible (disaccharides, certain oligosaccharides and non-structural polysaccharides), fermentable (lactose, certain oligosaccharides, dietary fibre and resistant starch) and non-fermentable (cellulose, lignin and certain dietary fibre). However, studies had indicated that grinding and

cooking improved digestibility of starch (Morris *et. al* 1977), and the same was observed by Murray *et. al* (2001) when cereal grains were subjected to high extrusion temperature, and furthermore they also observed a significant decrease in the amount of resistant starch.

The excessive use of carbohydrates raw materials, especially from corn, wheat, tapioca should be avoided. The use of carbohydrate should not be more than 10%, in order to emulate the natural feeding characteristics of the cats in the wild (Peterson 2011a). Cats by nature are an obligate carnivore, which totally feed on protein, with minimal amount of carbohydrates, where the latter may come from the cats feeding on grasses and small shrubs (cellulose type of carbohydrate). The digestive system of cat is not made for large proportion of carbohydrate digestion due to short intestine tract compared to that of the dog and absence of gastric enzymes (NRC, 2006). Fibre is used in the cat food preparation to ease constipation (Moser, 1992).

Cats with no apparent health problem can tolerate, grow and reproduce with as much as 15 to 20% total dietary fibre (TDR) in their diets (Fahey, 1995). The typical crude fibre content of cat food is between 2.5 and 4.5%. However, in reduced calorie diet, the TDF may make up 9 to 10% of the total diet composition (NRC, 2006). The usage of high level of fibre in weight reduction diet may allow the animals to achieve a sense of fullness without a high energy intake (Brown, 1990), and at the same time ameliorate the intestinal function (Markham and Hodgkins, 1989). One of the best sources of dietary fibre that had been shown to give rise to good stool characteristic, without significantly reducing nutrient digestibility is beet root (Fahey *et al.* 1990a,b., Sunvold *et.al*, 1993), due to the fact that it contains both digestible and non-digestible fibre in the ratio of approximately 20% and 80%, respectively (Fahey 1995).

The main popular source of carbohydrates used in pet food manufacturing by many dry kibble manufacturers are: wheat, corn, potatoes, sweet potatoes, tapioca and rice; For canned cat food, manufacturers prefer to use rice, potatoes and sweet potatoes as their ultimate choice. The best optimum usage is recommended below 10%, however, most of the cheap stuffs cat food are known to contain above 10% and some even to as high as 60%-70% (ACISB, 2011, 2012).

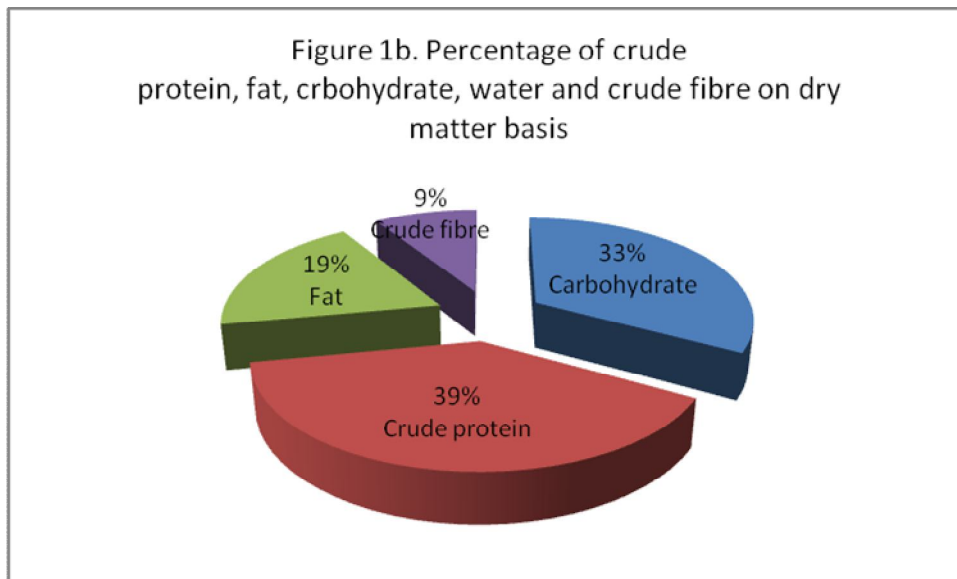
### ***How to calculate carbohydrate content in dried cat food and canned cat food***

It is interesting to note that, all commercial cat food had no published content of carbohydrates on the label. Carbohydrate had no role to play in the contribution to the well-being of the cat. In fact it is the source of obesity, and feeding high concentration of carbohydrate may induce feline urologic syndrome, due to high accumulation of carbohydrate concentration resulting in magnesium ammonium phosphate crystal precipitation (struvite) (Tarttelin, 1991).

The following formula shall be used to calculate the percentage of dry matter and dry matter weight of each nutrient available in the cat food. The carbohydrate concentration in each of this cat food formulation will be revealed for scrutiny.

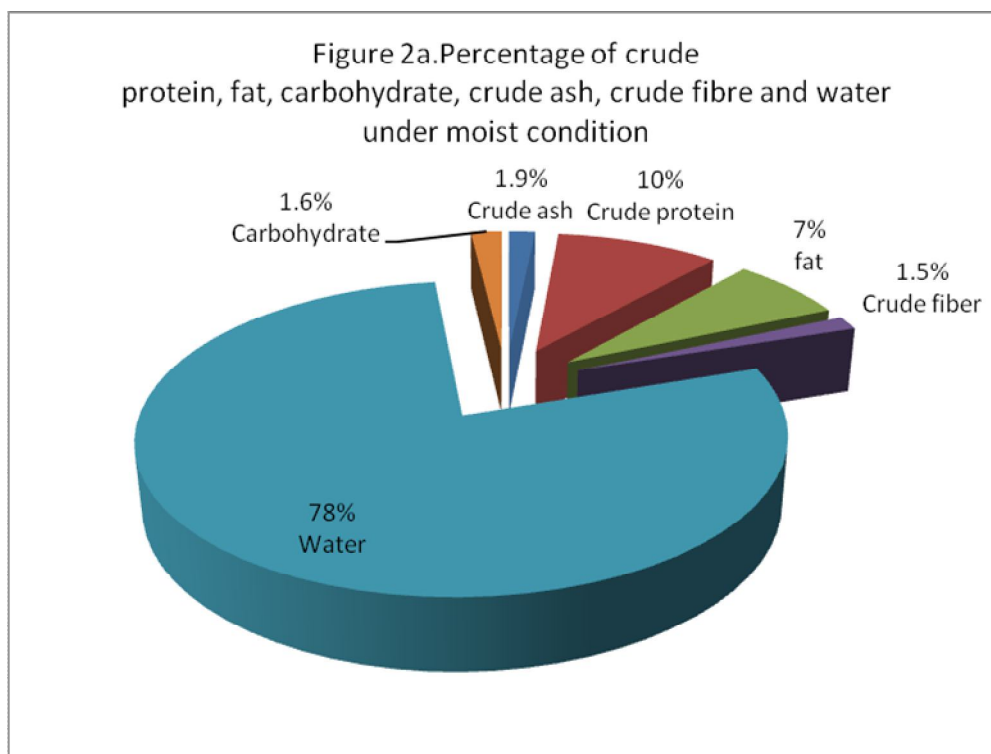


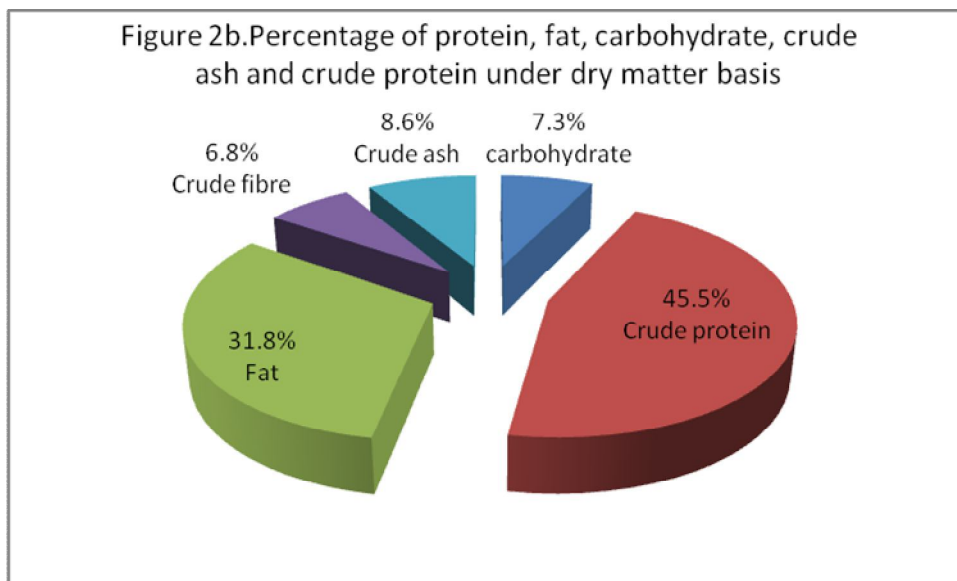




Guaranteed Analysis for Selected Canned Cat Food of Premium Quality, (156g USD1.6)		
Under Moisture (Figure 2a)	Dry Matter Basis (Figure 2b)	
Protein	10%	$10/22 \times 100 = 45.5\%$
Fat	7%	$7/22 \times 100 = 31.8\%$
Crude Ash	1.9%	$1.9/22 \times 100 = 8.6\%$
Crude Fibre	1.5%	$1.5/22 \times 100 = 6.8\%$
Moisture	78%	-----Nil-----
Carbohydrate	1.6%	$1.6/22 \times 100 = 7.3\%$

Therefore, the percentage of carbohydrate content should be  $100\% - (10+7\%+1.9+1.5\% +78\%) = 1.6\%$  (Figure 2a), while the dry matter percentage is  $100\% - 78\% = 22\%$





Protein content of the canned cat food is derived mainly from Fish broth, ocean fish, chicken kidney, chicken liver, turkey, whilst fat from all the mentioned protein sources, and avocado oil, and the carbohydrate and fibre from rice flour, oat bran, guar gum and carrageenan. All the above protein sourced raw materials are not rendered, thus of superior quality than those of dried cat food raw materials (chicken by-product meal, the main primary protein raw material – which is rendered). The amount of carbohydrate and fibre used are minimum, since these raw materials are listed at the end of raw materials listing. Michael (2012), pointed out that in the USA, the breakdown of Protein 40-45%, Fat 25-35% and Carbohydrate 2-8%, and the rest of the canned cat food is fibre, vitamins and minerals.

**Conclusion**

Care had to be taken when purchasing and reading the label is prerequisite in order to make the best choice for your pet. The term chicken meal/ meat meal/ meat bone meal/poultry meal - ending with the word ‘by-products’ which translate to contain feet, hooves, offal, skin and coats, intestine, neck and undeveloped eggs, entrails and other parts of the animals which are considered of the lowest quality of all types of meals. In comparison, fish/chicken/turkey/lamb/meat/bone meal – ending with the word ‘meal’, which may contain high amount of protein then the former but without: blood, hair, hooves, horns, hide, trimmings, manure, stomach and stomach content, feathers, head, feet and intestine.

It is advisable to select pet food using named meat meal, better still with human grade named meat and wholesome grains in order to ensure you pet get the best food. Most of the pet-foods available in the market are made from waste products and are of poor quality. It is important to note that pet-food industry is an extension of the agriculture sector and not merely churning waste animal products into profit without considering the palatability and digestibility of these products to these companion animals.

Cheap source of protein are derived from the following animal protein sources, arranging in descending order: Turkey by product meal, poultry by product meal, chicken by product meal, meat meal, meat and bone meal, meat meal by-products and bone meal. Goats are very rarely available in the USA, compared to 37 million cows and 100 million hogs slaughtered yearly and almost all the meat meal and meat meal by-products contained cattle

and pig residues. Meat meal as a source of protein for cat food manufacturing is unpopular and grouped into the same category as meat bone meal and meat by-product meal, since the source of protein is undefined. The meat source can be derived mainly from cows, pigs, goats and sheep. Therefore, it is absolutely safe to state that the term 'meat meal, meat bone meal, meat by-product meal' of western origin, including those from China may contain pig residues. These residues which are believed to be widely utilised in the manufacturing cat-food world-wide may not bode well with the Islamic uses, since these residues are non-halal and even handling them is forbidden.

Most of the cheap commercial cat food in the Malaysian market are dominated by vegetables sourced protein, where they are the core primary ingredients listed in the hierarchy listing order. The main protein source maybe derived from by-product meals of animal origin or meat bone meals. Fish meal is another favourite protein source used to manufacture cheap cat food, but minimal utilisation (not favoured by commercial cat food manufacturers) due to high ash content about 19%.

For the production of medium range priced cat food, the choice of protein are as follows and they are arranged in the descending order to reflect their pricing and their preferential use by the manufacturer: lamb meal, turkey meat, poultry meat meal, chicken meal, fish meal and meat meal. High quality and high priced dried pet food and canned pet food are manufactured using human grade meat and they are non-rendered. In addition, those named meat classified unfit for human consumption (after removal of prime meat for human consumption) are widely used for dried cat food and canned cat food manufacturing, but of lower grade than the above preparation.

Generally, high fat diets appear to be highly palatable to cats than low fat diets. To further increase the cat food palatability, the kibbles were further sprayed with protein hydrolysates, meat extracts and digest, which contain amino acids, peptides and fatty acids in viscous form, and the latter had been reported to improve palatability of cat food by two to threefold over uncoated products. Furthermore, coconut oil is unpalatable and failed to support cats' growth. Preference for beef tallow over butter and chicken fats but no preference were noted between beef tallow, lard or partially hydrogenated vegetable oils among cats. Crude fat content of commercially dried cat food may contain between 8 and 13% on dry matter basis, however, some of the premium products may contain between 18 - 20% fat on dry matter basis.

The main popular source of carbohydrates use in dried pet food manufacturing is: corn grit, corn gluten meal, soya bean, soya bean meal, potatoes, sweet potatoes, tapioca and rice. For canned cat food, manufacturers prefer to use rice, potatoes and sweet potatoes as their ultimate choice. The best optimum usage of carbohydrate is recommended to be below 10%, however, most cat foods are known to contain above 35-45% and some even to as high as 60-75%. Corn grit, corn gluten meal, soya bean are among the favourite type of ingredients use to make the cat food protein rich, but these protein sources are not readily digested and are poor in amino acid contents compared to meat source protein. Soya bean source protein, either gluten meal or fine powdered meal is not suitable for cat food manufacturing because this raw material is indigestible by cat. This is due to the fact that cat had short intestine and small stomach and had no capacity to digest this legume flour (in the absence of enzyme) and furthermore its attribution to skin allergies.

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