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FVR discuss

Farina Vet Research Journal

Growth dynamics of a puppy during its first year of life.

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VET Research

Farmina Vet Research

Farmina Vet Research Group (FVR), with its scientifically demonstrated dietary nutrients (Vet Life Formula), aims to support the Veterinarian with the management of some pathologies commonly occurring in pets.

It also intends to provide valid solutions to dietary problems and scientific consultancy through the cooperation of the Animal Science and Food Control Departiment of the Faculty of Veterinary Medicine of University of Napoli Federico II (Scientific Representative Prof Monica Isabella Cutrignelli).

Farmina Vet Research is capable of maintaining a scientific dialogue with the Veterinary world, delving into clinical and dietary issues.

Farmina Vet Research is part of the scientific division of the Farmina firm supported by the competence and the hard work of several professionals focusing on delivering effective consultancy services.

Farmina Vet Research integrates its production by studying technological innovations and by improving new products through manufacturing processes aimed at keeping up with future challenges. The high quality of its products contributes to the wellbeing and health of our pets.

The members of Farmina Vet Research are Dr. Massimo Casaburi (Veterinarian) in charge of the sector; Dr. Giuseppe Barba (Veterinarian) online consultant for FarminaChannel; Dr. Sergio Bianchi (Agronomist expert in Animal Science), responsible for the analysis laboratory and the formulas; Dr. Valentina Minchiotti (Veterinarian), responsible for the clinical trials.

Study carried out in agreement with Department of Animal Science and Food controll of the University of Naples "Federico II".

Growth Dynamics

In dogs, the growth phase is characterised by several significant changes during a relatively short time, if compared with other animals or humans. In particular, this occurs in puppies of large dog breeds in which the growth in length can be astonishing. Such puppies reach their final size between 16 and 18 months.

We can identify four fundamental phases in the life of a puppy, since its birth until its adult age:

1. The birth, a period including the first very important hours of the animal;
2. The suckling, which represents a passage from the intra-uterine feeding to the post-birth feeding. During this phase, lasting from the birth to the first 4-7 weeks, the influence of the food assimilated by a pregnant and lactatingg mother is very significant;
3. The weaning which consists of milk and solid feeding. A correct weaning results in correct digestive functions and contributes to development of both the bone and joint system and the immune system;
4. The post-weaning period going from the 2 to 12-14 months, according to the size. The correct feeding management in this period is fundamental for somatic and skeletal development. This is particularly important in large and giant size subjects as it represents the non genetic factor mainly influencing their skeletal development (Debraekeleer et al., 2000).

It is essential to satisfy the nutritional requirements of dogs during these phases in order to guarantee the best development and the achievement of the correct size once an adult.

Growth is a process involving interactions between genetics, nutritional and environmental interference. Therefore, feeding must take into consideration the nutritional requirements of each different subject, varying according to age: a puppy has higher

nutritional requirements compared to an adult dog as it has to develop its bones, its muscles and its organs. A complete and balanced diet plays an important role in the growth and the development of a puppy: our goal is to create an adult dog enjoying optimal health by reducing to the minimum the risk of obesity and of skeletal development diseases.

Suckling

Immediately after the birth, the mother produces colostrum which is a particular mammary secretion containing antibodies and other immunostimulating substances protecting the new born puppy form infections. These protective substances can be assimilated by the intestine only during the first 24 hours of life; it is therefore very important that the puppy suckles soon as possible. The assumption of colostrum in the first hours of life positively affects the volumetric development of the cardiovascular system.

Twenty-four/seventy-two hours after the birth, the mammary secretion slowly turns into milk. During the first 3-4 weeks, puppies should suckle not less than 4-6 times a day. During suckling, on average a puppy should increase its weight by 2-4 g per day for each kilogram of weight estimated as an adult. It is necessary to provide a nutritional integration or utilise a milk equivalent product. In healthy puppies, mother's milk is sufficient for a correct growth until about the fourth week and the integration with milk equivalent products is necessary just in case of excessively numerous litters or in case the milk production is discontinued or drastically interrupted. Subsequently, mother's milk alone can no longer satisfy the increased nutritional requirements necessary to guarantee the correct puppy development. Therefore it is necessary to carry out the weaning in order to introduce new nutrients and foods.

Weaning

The introduction of solid food should start in the 3rd – 4th week, in order to obtain a satisfactory consumption of solid food in the 5th week, when the physiological decrease of milk production occurs (Debraekeleer et all 2000). During this phase the first semi-solid food is introduced. Such food is mixed with a small quantity of warm water to create a dense meal which the puppy should eat three times a day. The quantity of water is subsequently reduced, until the complete elimination. Dry foods without adding any water can be introduced from the 6th week. Most puppies stop the consumption of mother's milk at the 8th week.

During the first six months, all puppies grow quickly although there are some significant differences of weight and development among the various breeds and sizes. Such differences are already noticeable in the weight at the birth and in the dimensions of the litter.

For instance, a female Poodle generally gives birth to 1 to 3 puppies, each one weighs about 5% of its mother weight; on the other hand German Shepherd litters can count up to 8-12 puppies, weighing at birth just 1% of their mother's weight.

Therefore, the duration of the growth phase and the growth rate vary significantly: after one year since birth, the Poodle will multiply twenty fold its weight whereas the German Shepherd will increase seventy fold its weight.

Generally, small and medium size dogs reach about 50% of their adult weight around the forth month whereas large size dogs reach it around the fifth month. Such growth differences imply different nutritional needs.

Large size dogs' growth rate has to be carefully controlled. In fact, during the first 12 months, those puppies grow rapidly and if the weight increases excessively, there is a high risk of overweight and skeletal pathologies.

During this phase, we can observe the rapid formation of tissues and the development of the organism resulting in an increased need of energy and nutrients.

Nutritional Requirements

The puppy nutritional requirements during the growth phase can be up to three time superior to the requirements of an adult dog. Puppies are very active and develop rapidly therefore, dietary nutritional elements must guarantee the maintenance of homeostasis (maintenance requirements) and, at the same time, of the growth (growth requirements).

Generally, during the first weeks after weaning, when the growth level is high, puppies utilise about 50% of the energetic intake from food for maintenance and 50% for growth. Whereas during subsequent phases, the energy amount utilised for the maintenance gradually increases to the detriment of the amount destined to the growth.

Nutrients producing energy, represented by carbohydrates, lipids and proteins, are mainly used to satisfy the energetic requirements and, subsequently, are available for other metabolic functions.

The carbohydrates of the the diet mainly carry out two functions: provide energy and help gut functions.

On the basis of their solubility, they can be differentiated as: simple or soluble carbohydrates such as soluble sugars and starch, and as insoluble carbohydrates such as cellulose.

Soluble carbohydrates represent a low cost energy source and allow significant protein saving. As a result, most pre-packed meals contain high concentration of soluble carbohydrates.

Fibre, instead, reduces the digestibility of the ration and its relative energetic density. Its presence, in meals, may contribute to maintain the ideal weight as it tends to reduce appetite by increasing the level of gastric repletion.

The researchers of the National Research Council (1985) recommend administering feed in which 20% of the dry substance is composed by carbohydrates to guarantee optimal health in growing dogs until the age of 4 months.

Lipids represent a very concentrated energetic source and, at the same time, they supply essential fatty acids. The levels of fat and fibre in a diet are factors determining the energetic density of a meal. By utilising the same amount, fats supply much more energy compared to carbohydrates and proteins. Therefore, rations containing high quantities of lipids are characterised by a high energetic density.

Throughout the growth phase, it is very important to avoid an excessive energetic supply in order to prevent obesity, which can negatively influence morphological and skeletal development. In fact, overburdened joints and young bones may lead to the onset of skeletal problems such as osteocondritis and hip dysplasia. Ruling out genetic influences, several studies have demonstrated that excessive weight in growing puppies, due to feeding, implies a significant increase of dysplasia incidence.

Growing dogs need a specific daily intake of essential fatty acids such as linoleic acid and α-linolenic acid. These elements are fundamental as dogs do not have or lack in the enzymes necessary to synthesize them from the fatty acids introduced through the diet.

Essential fatty acids perform several functions:

- Carry out structural functions in cell membranes;
- Are precursors of substances such as prostaglandins, leukotrienes and thromboxanes;
- Maintain the hydration and elasticity of skin and hair;
- Influence fertility.

In particular, it is recommended to take 250 mg of linoleic acid for each kilo of body weight. In order to achieve such quantity, it is necessary to utilize vegetal oil and seafood fats which contain more linoleic acid than animal fats.

In growing dog the protein requirements is higher than in an adult dog. Proteins are fundamental elements in the body as they play a role in the growth and in the tissue repair process. During the growing period, the increased need of proteins is linked to the formation of new tissue and to an increased energetic consumption.

In the past, it was thought that an excessive protein intake could play a role in the development of skeletal conditions in giant size dogs whereas, presently, it is believed that the use of diets containing proteins up to 31% of dry mattere does not imply any risk if the level of calcium and energy supplied are balanced.

During the growing phase the calcium and phosphorus requirements increase compared to an adult dog. Commercial feed contain a proper, and sometimes excessive, quantity of calcium and phosphorus therefore, they do not need any integration: on the contrary, calcium is often lacking and phosphorus could be excessive in home made diets, especially if mainly constituted by meat and kitchen leftovers.

In the most serious cases, calcium deficiency leads to a calcification of growing bones, increasing the risk of fractures. This is particularly dangerous for large size dogs that grow at a fast rate.

At the same time, also an excessive ammont of calcium can cause damage as it can destroy the balance between bone construction and destruction: the bone can no longer grow normally and cannot adjust to always changing environmental conditions. Excessive calcium intake reduces the absorption of phosphorus, iron, zinc, copper and may lead to forms of deficiency of the above mentioned minerals.

Also phosphorus plays an important role during growth as it is tightly correlated to the levels of calcium. In fact, an excessive quantity of phosphorus inhibits calcium absorption and by doing so it reduces the calcium present in the blood and releases the calcium contained in the bones.

Feed for puppies should contain 0.80% SS of calcium and 0.67% SS of phosphorus and the calcium-phosphorus ratio should be ranging between 1/1 and 1.8/1. Excessive calcium should be avoided for the inhibiting effect that it can have on the absorption of zinc and copper, which are particularly necessary between the fourth and the sixth month of life.

The need of copper in growing dogs ranges between 0.25 and 0.5 mg/kg of body weight. Copper and iron are oligoelements essential for the formation of

hemoglobine and several other enzymes; moreover, together with zinc, it helps the development and the subsequent maintenance of skin and hair. The lack of copper may lead to alteration of the coat and, in the most serous cases, the normocytic normochromic anemia.

Dogs fed with complete feed do not need any further vitamin and mineral supplementation; on the contrary, a contribution of mineral salts and vitamins, especially of the group A, E, B, D and PP, is recommended for dogs fed homemade diets.

Vitamins A and E, together with a balanced intake of calcium and Zinc, are very important for the protection of the immune system. Vitamin D is important in the regulation of the metabolism of calcium; nevertheless, it must not be administered in excessive quantities as it may cause an imbalance in calcium and phosphorus metabolism and may cause problems to the normal growth of bones.

The evaluation of the administration method is essential for the correct management of puppy growth. Further to the qualitative aspect of food, it is also necessary to consider to quantity aspect.

It is usually recommended to give defined food amounts (Debraekeleer et al., 2000), as it allows a better control of the body weight and of the growth rate, whereas abundant feeding is recommended only in the case of very thin dogs (Body Condition Score 1 or 2 using the point scale proposed by Laflame et al., 1994) or with difficulty to keep the adequate body weight.

Depending on the type of feed, in particular if it is used dry feed, it is important to give dogs plenty of water. Water constitutes approximately 56% of the body weight of an adult dog and it represents the most important element as water deprivation is much more harmful than the deficiency of other nutrients.

The total water absorption, drunk by the pet and taken in through meals, is influenced by various factors such as the environment, physiological conditions, activity and chemical composition of the diet.

During the growing phase, it is therefore important for the dog to fed a specific ratio. Such the daly amount can be divided into two up to four meals (Debraekeleer et al, 2000; NCR, 2006).

The choice of an appropriate feed, both from the quality and quantity point of view, is an essential condition to avoid risks linked to fast growth, especially in dogs belonging to some particular breeds.

Debraekeleer et al, (2000) considered ideal for puppy growth the following chemical-nutritional characteristics:

- 15-30 % protein (high quality, especially of animal origin);
- 10-20% lipids;
- ≤ 5 % raw cellulose;
- 0,50 - 1,00 % calcium;
- 0,40 – 0,90 % phosphorus;
- 0,20 – 0,40 % sodium;
- 0,3 – 0,6 % chlorine;
- 3,5 -4,5 kcal/EM/g

Experimental part
Materials and methods

Animals

This test was carried out on a German Shepherd breeding farm in the countryside of Naples. When pregnancies were diagnosed through palpating around the 25th day, 3 pregnant females where selected.

After the delivery 18 puppies where selected (9 males and 9 females) according to their sex and weight at birth.

At the age of 21 days, the puppies where equally divided into two groups. From the 28th day since the assumed delivery date, each new mother was put in a box of 6 square metres, entirely fenced with a zinc-coated metallic net of 2.20 metres of height. The floor was non-skid type, completely washable and with external drainage for droppings. The boxes were subdivided in an anterior zone of 4 square metres and in a posterior zone of 2 square metres. This portion, in masonry, was used as a shelter for the night and it was also used as delivery room. To this aim, a delivery crate of 1 square metre was also set up, with a side 50 cm high, with an anti-crushing edge and raised from

the floor in order to guarantee both a better thermal isolation and protection from humidity.

In correspondence to the delivery crate, a 200 watt infra-red-rays lamp was also applied to the ceiling at a distance of about 70 cm from the puppies, in order to guarantee a constant body temperature of the new born dogs through irradiation.

From the 3rd week, the number of hours during which the puppies where kept separate from their mothers increased. At the 5th week the puppies were separated completely.

To this aim, puppies where subdivided into two groups and put up in smaller boxes with the following characteristics: area 3 square metres, covered with caulking sheet metal placed at 2.20 m of height in the posterior part and inclined towards the anterior part. The floor of the boxes was non-skid and completely washable, equipped with an external drainage for droppings and there was a metal net fence.

The feeding of the puppies was given three times a day. Water was given to the young dogs in small dosages in order to prevent puppies from playing with the water bowl and to avoid waste.

Puppies were vaccinated in compliance with the rules of the breeding farm as follows:

Age	Vaccine
28 gg	puppy (gastroenteritis, distemper)
60 gg	gastroenteritis
75 gg	trivalent (distemper, hepatitis, leptospirosis)
90 gg	gastroenteritis
105 gg	trivalent (distemper, hepatitis, leptospirosis)

The aim of this test was to compare two commercial dry pet-foodsformelated to satisfy the nutritional requirements of growing dogs, form the weaning to the reaching of the age of 12 months.

Food

The mothers, since the pregnancy, had been fed a commercial complete diet, normally used in the breeding farm. Their daily energetic requirements (kilocalories of metabolizable energy_ME) were calculated as recommended by the researchers of the National Research Council (2006), using the formula (130*kg pv0.75). The maintenance need was then multiplied by 1.1; 1.2 and 1.3 in the third from last week of pregnancy. Then, depending on the energetic density of the food, the daily dose was calculated and subdivided into two meals given every 12 hours. Instead, the queens had free access to the water that was changed three times a day.

For weaning, from the 21 day, puppies belonging to two groups were given complete food created for the growth and pre-emptively softened with warm water.

The choice of the diets was made among those chemical-nutritional characteristics suitable for the development phase, particularly common in breeding farms in Campania (South Italy).

The individual requirements for both groups were calculated using the following formula (NRC., 2006):

FEM = [30*kg0.75 * 3.4 * (e (-0.87p)- 0.1)]

Where FEM is the daily energetic requirementfor maintenance expressed in kilocalories; e is the

logarithm in natural basis ≈ 2,718 and p the difference between the present weight and the estimated adult weight. Once established the individual requirements, the daily ratio was calculated and was readjusted every week.

Controls

Since the birth and for all the 1st week of life, the puppies had been kept under observation in order to guarantee each subject access to their mother breasts. Moreover, the weight and rectal temperature were checked every day at 10:00 a.m. Subsequentlythe weight control was carried out weekly for all the first year of age adjusting continually the daily administration according to weight variations. The daily food intake was recorded by weighing the refusal of each meal. The study on the growing dynamics of the dogs was performed starting from the calculation of the individual growth rates instead of using the real weight as this procedure allows to reach more broaden results. It also allows the reduction of random mistakes on weight calculation which often lead to a significant variability of weight related results (Pilla, 1991). In order to highlight any possible dysplastic condition, all the puppies underwent X-rays at the age of six months and one year..

Samples and determinations

Periodical samples of all the diets were taken and analised for chemical composition according to AOAC 2006, (Commission in charge of the evaluation of Animal food).

Statistical Analysis

The individual growth rates were calculated following by PROC REG of SAS (2000). The data were analyzed by the t of Student by PROC GLM of SAS (2000).

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Results and discussion

In the tables 1 and 2 are respectively reported the ingredients and the average values of the chemical composition of the feed utilized for the weaning.
In the analysis of table 1 it is possible to see some differences between the different feeds, in particular, the table of ingredients of the feed 1 indicates that the food mainly represented is a cereal (rice), whereas in table 2 the mainly represented food is meat (dehydrated chicken meat). It is also important to highlight that both pet-food have been supplemented with functional ingredients. In the first, fructo-oligosaccharides and mannan oligosaccharides are present. The second type contained inuline. In both cases this involves complex carbohydrates capable of promoting the development of gut microbial population. This is particularly recommendable in

Table 1 – Diet Ingredients

Mangime	Ingredienti
1	Rice, dehydrated chicken meat, isolated vegetal proteins animal fats, protein from chicken, chicken livers, mineral salts, vegetal fiber, beet pulp, fish oil, powdered eggs, soy oil, fructo oligosaccharides, L-lysine, sodium polyphosphate, hydrolyzed yeast (source of mannan-oligosaccharides), taurine, DL-methionine, tegument and grains of psyllium, hydrolyzed seafood (source of glucosamine), hydrolyzed cartilage (source of chondroition), extract of flower of Tagete (source of lutein).
2	Dehydrated chicken meat, rice, corn, animal fat, whole dehydrated eggs, corn gluten fild , dried beetroot pulp, linen seeds, fish oil, digest, vegetal oil, inulin, potassium chloride, calcium carbonate, dried brewer's yeast, calcium hydrogen phosphate, sodium chloride, DL-methionine, L-lysine, glucosamine, Chondroitin sulfate, Zinc oxide, Zinc sulfate, copper oxide, ferrous sulfate, ferrous carbonate, manganous sulfate, Calcium iodide, cobalt carbonate, sodium selenite, Beta-carotene, vitamin (colin chloride, vitamin A, vitamin D3, vitamin E, vitamin C, vitamin PP, d-pantothenic acid, vitamin B2, vitamin B1, vitamin K3, vitamin H, folic acid, vitamin B12.

Table 2 – Chemical composition and nutritional value of food for weaning

Feed		1	2
Moisture	% t.q	9,5	8,1
Crude protein	"	29,8	29,1
Ether extract	"	16,1	22,0
Crude fiber	"	1,9	1,3
Ash	"	6,0	6,5
Metabolizable energy	kcal/g	3,7	4,1

critical phases such as weaning, when the microbial population and digestive tract isn't developed yet.

Furthermore, the German Shepherd race has always been considered particularly delicate at the gastroenteric level due to the scarcity of microorganisms (German and Zentek, 2006).

Both feeds present chemical-nutritional characteristics suitable for the growth and resulted in being particularly appetizing. In fact, except for some sporadic cases particularly occurred in the first day of administration, the leftovers were almost absent.

With reference to the study on growth dynamics, the square function showed a better adaptation to experimental data than the allometric function. The equations obtained showed coefficients of determination never inferior to 0.9851. Therefore, the weight survey carried out on each puppy was adjusted to the following function:

$$Y = a + bX + cX^2$$

Where Y= live weight (kg); X = age (die)

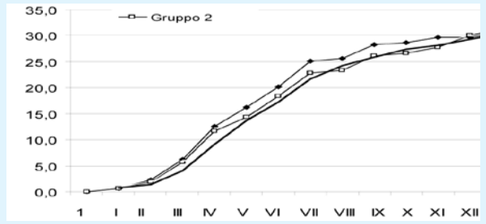
From the growth rates of each subject were calculated the following data: the estimated live weight at 1, 7, 21 and 28 d and to at months 2nd , 3rd , 4th , 5th, 6th , 7th , 8th , 9th , 10th , 11th, and 12th . Starting from the above mentioned data, the weight increase were calculated (IP, g/die) at the intervals 1/7; 1/21; 1/28; I/III; III/VI; 1/12th ; 28/12th ; and the index of alimentary conversion (g dm/g dwg) in the periods 21/28; 1st/3rd , 2nd/6th; 6th/12th 28/12th.

The estimated weights are reported in table 3, and figure1 shows the average growth rates trends registered in the subjects belonging to both groups.

Table 3 – Estimated average weights (kg)

Age		Group 1	Group 2	Var. er.
0	day	0,575	0,573	0,011
7	"	0,802	0,749	0,009
21	"	1,402	1,625	0,028
28	"	2,012	1,605	0,061
2	month	6,262	5,752	0,418
3	"	12,580	11,692	1,477
4	"	16,254	14,275	2,176
5	"	20,195	18,327	1,553
6	"	25,151	22,880	5,486
7	"	25,625	23,289	7,260
8	"	28,250	26,107	8,503
9	"	28,712	26,589	8,364
10	"	29,711	27,739	6,854
11	"	29,714	30,086	7,391
12	"	30,520	31,297	7,804

Chart 1 - Average growth rates in the two groups and trend lines.



No statistically significant differences emerged even if phases of slower growth alternated to phases of recovery. This is clearly shown in the chart: until the third month of life, puppies from both groups showed almost overlapping weights, whereas during the following months, until the age of 10 months, the puppies belonging to group 2 showed lower weights compared to the puppies belonging to Group 1. Group 2 the showed a compensative growth in the last two months of the trial. This allowed the animals fed with feed 2 to reach an average weight, at 1 year of age, superior to the animals belonging to group 1. It is important to specify that, at the age of 1 year, all the subjects reached weights close to 90% of their weight as adults, as indicated by the breed standard for both sexes.

More precisely, the male subjects reached an average weight of 32.9kg, equal to 94.15% of the adult average weight, whereas the female subjects weighed on average 25.5kg at 1 year of age, equal to 94.4% of their adult weight.

Table 4 shows the average values of weight increase recorded in different periods. During the suckling period, in both groups the puppies did not reach a weight increase considered optimal for the breed (from Lewis at al. 1993) which, in the case of the German Shepherd, should be equal to 93 g/die, probably because of the not very high energetic concentration in the milk, as aobserved in a previous trial conduced in the same farm (Cutrignelli et al., 2006), compared to what reported by literature.

No significant differences emerged during the weaning.

Table 4 - Weight increases (g/d)

Period	Group 1	Group 2	Var er
0-7	32,40	25,08	0,404
0-21	50,00	39,43	0,381
21-28	55,30[a]	39,37[b]	0,649
0-II	53,93	41,95	0,658
I-III	200,10	185,30	4,381
III-VI	135,15	120,30	4,410
VI-XII	29,67	46,5	0,967
0-XII	82,03	84,20	0,095
28-XII	84,60	88,12	0.025

a,b =P<0,05

Starting from the period 0-7 until the 6th month of age, group 1puppies did not achieve a higher weight increase compared to that of group 2, even if the differences were statistically significant ($p > 0.05$) just in the period 21-28. On the contrary, Group 2 recorded a higher weight increase in the period of 6th-7th months. Such increases allowed the subjects in this group to reach weights overlapping those of Group 1, at the end of the test.

Comparing the results obtained in this test with those obtained by Cutrignelli et al. (2006), puppies belonging to both groups achieved, in the first 3 months of life, weights and weight gain overlapping

Table 5 – Feed convertion indexes (g DM/ g DWG)

	Group 1	Group 2	Var. er.
21-28	8.75	12,62	6,82
I-III	18,05	18,49	3,04
III-VI	674,45	696,77	1875,7
VI-XII	3089,3A	1884,8B	1534,7
28-XII	1518,2a	1358,6b	1833,1

A,B =P<0,01; a,b =P<0,05

those achieved by puppies fed with 2 premium feeds during the previous trial .

However, these weights and weight gains were significantly lower compared to those achieved by puppies fed with a cheaper and a premium diet. Moreover, with the German Shepherd breed, which is particularly prone to bones and joints problems such as hip dysplasia, it is preferable to have a slow and harmonious growth in order to prevent alteration of the skeletal development, as indicated by Kealy et al. (1992). It is also particularly interesting the comparison between the groups with reference to feed conversion indexes (table 5).

Group 2, which during the first six months recorded inferior weights and increases subsequently showing a compensative growing phase, utilized dry food quantities significantly lower compared to Group 1 ($P<0.01$ and $P<0.05$, respectively in the periods 6th-7th and 28-12th).

During the whole phase of solid feeding, the puppies receiving food 2 utilized about 160g of dry food less for each gram of weight gain compared to those fed diet 1.

Even without a precise analysis of costs, the economic advantage deriving from this data is clear.From the analysis of the results described so far, feed 2 seems to be more suitable to guarantee a modulated growth during the initial phases after the weaning period and, consequently, a better skeletal development.

Study carried out in agreement with Department of Animal Science and Food controll of the University of Naples “Federico II”.

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