# THE EFFECT OF HEAT PROCESSING OF FOOD
# ON THE
# DENTO-FACIAL STRUCTURES OF EXPERIMENTAL ANIMALS

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We performed a feeding experiment with cats in our laboratory a few years ago to determine the effect of heat treated foods upon growth and development. This experiment stemmed from the fact that we suffered steady mortality among the cats on which we were performing adrenalectomies for the purpose of standardizing adrenal cortical material. We were feeding these animals the meat scraps from the Sanatorium, together with raw milk and cod-liver oil. The cats were poor operative risks although our technique was good. In time, more cats had been given to us than we were able to feed on the scraps from the Sanatorium. We placed an order for raw meat scraps at the market where the Sanatorium meats were bought; these scraps included muscle, bone and viscera. This raw meat was fed each day to the same group of cats. Within a very short time the cats in those pens survived the operations, the unoperated cats appeared to be in better health, and the kittens born were vigorous. The contrast in apparent health between the cats in the pens fed on raw meat scraps and those fed on the cooked meat scraps was so startling that we decided to do a feeding experiment.

We kept the cats in open-air pens with a yard four feet wide, seven feet high, and twelve feet long, one end having a roof, and a floor with bedding.

We followed a routine procedure with each cat. We weighed, numbered and described each cat, getting all the information possible from donors regarding the type of food the cat had received before we placed it in our pens. We kept clinical notes, including weights. We described and weighed each kitten as it was born, giving parentage, behavior of the mother during the birth, and continued clinical notes on all kittens. In case of death, we performed an autopsy, cataloguing gross and microscopic findings. We did a calcium and phosphorus determination on the femur. At the close of the experiment, which ran for ten years, we autopsied all remaining animals.

In our first series of experiments, we fed one group of cats a diet of two-thirds raw meat, one-third raw milk, and cod-liver oil. We fed the second group a diet of two-thirds cooked meat, one-third raw milk,and cod-liver oil. Within the ten year period, we studied a total of nine hundred cats. The amount of data accumulated is enormous. In this paper, I shall present only the general predominating findings.

The cats receiving raw meat and raw milk reproduced in homogeneity from one generation to the next. Abortion was uncommon, litters averaged five, and the mother cats nursed their young in a normal manner. The cats in these pens had good resistance to vermin, infections and parasites. They possessed excellent equilibrium; they behaved in a predictable manner. Their organic development was complete and functioned

normally.

Cats receiving the cooked meat scraps reproduced a heterogeneous strain of kittens, each litter of kittens being different in skeletal pattern. Abortion in these cats was common, running about 25% in the first generation to about 70% in the second generation. Deliveries were in general difficult, many cats dying in labor. Mortality rates of the kittens were high, frequently due to the failure of the mother to lactate. The kittens were often too frail to nurse. At times the mother would steadily decline in health following the birth of the kittens, dying from some obscure tissue exhaustion about three months after delivery. Others experienced increasingly difficult pregnancies. Some failed to become pregnant. For all breeding purposes, except special studies not reported here, we used a normal, raw-meat fed male, proven fertile, thus eliminating the possibility of male infertility.

Cooked meat fed cats were irritable. The females were dangerous to handle, occasionally viciously biting the keeper. The males were more docile, often to the point of being unaggressive. Sex interest was slack or perverted. Vermin and intestinal parasites abounded. Skin lesions and allergies were frequent, being progressively worse from one generation to the next. Pneumonia and empyema were among the principal causes of natural death among the adult cats. Diarrhoea, followed by pneumonia, took a heavy toll of the kittens. Osteomyelitis was also both common and fatal. Cardiac lesions,

some ascertained clinically, were frequent. Hyperopia and myopia, thyroid disease, nephritis, orchitis, oophoritis, paralysis, meningitis, cystitis, arthritis and many other degenerative lesions familiar in human medicine, were observed.

Of the cats maintained entirely on the cooked meat diet, with raw milk, the kittens of the third generation were so degenerated that none of them survived beyond the sixth month of life, thereby terminating the strain.

We took a group of cats fed on raw meat and placed them on a cooked meat diet for six months, then returned them to the raw meat diet. When females of this group became pregnant, their kittens suffered some of the aforementioned stigmata, though the female herself appeared to be in good health. Her succeeding litters would show irregularities that tended to lessen in intensity through several generations as long as they received the raw meat diet. Her resistance to disease, greatly diminished when the cooked meat diet was administered, gradually improved upon her return to the raw meat diet. She would maintain her skeletal form but her calcification would not return to normal. Her reproductive efficiency would be injured from the standpoint of the size and vitality of her kittens, and the failure of the subsequent litters to conform to a homogeneous pattern.

We took cats of the first and second generation cooked meat fed groups and returned them to a raw meat diet. We classified them as "regenerating" animals of the first and

second order, first, second, third and fourth generations.

It apparently requires four generations for either order to regenerate. However, because of lack of reproductive efficiency, it is only the occasional animal that returns to normal. Improvement in resistance to disease is noted in the second generation regenerating cat. Allergic manifestations persist. Reproduction is erratic. In the third generation regenerating, skeletal and soft tissue changes continue though to a lesser degree. In the fourth generation, the occasional animal appears normal.

At autopsy, cooked meat fed females frequently presented the picture of ovarian atrophy and uterine congestion, whereas the males often showed failure in the development of active spermatogenesis.

The long bones tended to increase in length in these animals, while diminishing in diameter. In the male, it was common to find the hind legs increasing in length over the fore-legs. The trabeculation of the bones became coarser and showed evidence of less calcium. In the third generation of cooked meat fed animals, some of the bones became as soft as rubber and a true condition of osteogenesis imperfecta was present.

In the cooked meat fed animals, visceral volume decreased, which was evident from the size of the thoracic and abdominal cavities. However, the males on the sweetened condensed milk showed distended abdominal cavities.

Before I describe the dental conditions that obtained

in the cats on the raw and cooked meat diets, I wish to state briefly that we did a second series of feeding experiments. In this series, we used the following kinds of milk: raw milk, raw metabolized Vitamin D milk, pasteurized milk, evaporated milk and sweetened condensed milk. Each type constituted two-thirds of the diet, the balance being made up of raw meat and cod-liver oil. Roughly, our results corresponded with those of the previous experiments; animals on raw milk and raw meat reproduced a homogeneous strain, the only causes of natural death being old age or injuries from fighting.

The cats fed on metabolized Vitamin D milk showed results very like those on pasteurized milk. However, an interesting circumstance occurred in the males fed on this milk. Young males did not live beyond the second month, and adult males died within eighteen months. The most notable fact was that the calcium phosphorous ratio became unbalanced, running 2.5 to 1, as compared with a normal of 2 to 1. On autopsy, several of the animals showed a calcium deposit in the adrenal gland.

The cats fed pasteurized milk as their principal item of diet showed lessened reproductive efficiency in the females, and some skeletal changes, while the kittens presented deficiencies in development. Cats fed evaporated milk showed even more damage. However, the most marked deficiencies occurred in the sweetened condensed milk fed cats. We believe that the excessive carbohydrate in this milk was responsible for much of this heavy damage.

Later, we made a comparative study of several types of milk on white rats, the general results of which coincided with those found in the cats. However, this is a separate subject.

Of particular interest to you attending the Dental Seminar are the dental structures of these animals. The cats fed on the raw meat diet from generation to generation maintained a regular, broad face with prominent malar bones, adequate nasal cavities, a broad dental arch and regular dentition. The configuration of the skull of the male is distinct and different from that of the female, and each maintained the normal configuration. The membranes were firm and of a good pink color, with no evidence of infection or degenerative change. In older cats, particularly the males that had engaged in much fighting, the incisors had often been lost, but in no raw meat fed cats did we see gingivitis or peridentosis.

Cats placed on a cooked-meat diet begin to show unhealthy conditions in the mouth within three to six months. A pregnant cat will show the change quickly. These cats first present gingivitis, then diminished calcium, peridentosis, abscesses, and finally, some shedding of the teeth. The canine is the last tooth to be shed.

CARIES DO NOT DEVELOP IN CATS FED ON ANY OF THE DIETS.

In the second generation of the cooked meat cats the new-born deficient animal shows an irregular development of the contours of the skull cap, a narrowing of the malar and orbital

arches and altered configurations of the mandible and maxilla. As this kitten grows and develops, these abnormalities become more prominent. The erupting teeth are frequently followed by bleeding gums and prostration. Even the deciduous teeth are irregular in size and shape and are apt to be delayed in shedding. Supernumerary and missing teeth are common. Teeth do not erupt at a regular time as they do in the raw meat fed cat. Most of the cooked meat fed cats show a longer and narrower face with a retraction in the middle third. There is frequently a recessive mandible or a protruding mandible.

The permanent teeth are, in general, more irregular in size and alignment than the deciduous teeth. Gingivitis persists, gums become spongy and abscesses gradually develop. It is through this process of secondary infection that most cats on a cooked meat diet lose their teeth. One of the most interesting factors is that the root of the canine in the second generation cooked meat fed cat frequently becomes squared off, and may be lost even before the other teeth. Loss of teeth in the deficient animal has come about as a result of peridentosis. Vertical trabeculation and erosion of the alveolar processes occur in these animals.

It is interesting to note that root resorption occurred more commonly among the cats fed a diet of heat processed milk than those receiving cooked meat.

The degenerative changes in the skull and mouth grew more pronounced in the third generation cooked meat cats. The

bones were very fine, with scarcely enough structure to hold the skull together. The teeth were smaller and much more irregular. When the permanent teeth erupted, the third generation cats were frequently prostrated.

In the regenerating cats, skull development is still deficient in the second generation, with a universal malalignment of teeth. The third generation regenerating cats show improvement, and in the fourth generation, an occasional cat will show normal skull and dental development.

After we performed these experiments, the pens in which all of these animals were housed lay fallow for several months. Weeds sprang up in each pen, as will be seen in the following slides. The fact that the weeds grew so luxuriantly in the pen which housed the raw meat fed animals, as compared with those which grew in the other pens, led us to perform a further experiment. We planned two kinds of beans in each pen, with results as seen in the following slides.

What vital elements were destroyed in the heat processing of the foods fed the cats? The precise factors are not known. Ordinary cooking precipitates proteins,[1, 2] rendering them less easily digested.[3] Probably certain albumoids and globulins are physiologically destroyed.[4, 5] All tissue enzymes are heat labile[6] and would be materially reduced or destroyed. Vitamins C and the $B_1$ Complex are injured by the process of

cooking. Wulzen and Van Wagtendonk[7] have described a thermo-labile substance in milk that may be one of the factors. Minerals are rendered less soluble by altering their physico-chemical state.[8] It is possible that the alteration of the physico-chemical state of the foods may be all that is necessary to render them an imperfect food for the maintenance of health.

The principles of growth and development are easily altered by heat and oxydation which interfere with living cells at every stage of the life process, from the soil through the plant, and through the animal. Change is not only shown in the immediate generation, but as a germ plasm injury which manifests itself in subsequent generations of plants and animals.

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