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Carbohydrate vs Protein: Which is a better diet for Indian free-ranging dogs?

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Abstract: During the process of dog domestication the dogs have undergone evolutionary change that resulted in seventeen fold increase in the Amy2B gene copy number. Amy2B gene encodes a pancreatic amylase which enables the dogs to be able to better digest carbohydrate than their carnivorous ancestors. Indian free-ranging dogs live in environment where their access to protein foods is limited. They survive mainly on starch based foods in the urban environment. In this experiment forty adult dogs were provided with either a carbohydrate diet or a protein diet. The aim of the experiment was to determine whether the different food sources would result in any behavioural changes in the dog. We found that the protein diet was the better diet for the dogs and under normal circumstances sex of the dog did not affect the energy acquisition from food source.

Index Terms- Amy2B, Indian free-ranging dog, dog domestication, carbohydrate food, protein food

I.INTRODUCTION

History of dog domestication

The domestication of the dog began in the Middle East and rapidly spread throughout the World. The early process, called proto domestication, was probably done unintentionally around 14,000 BC[1]. Domestic dogs have descended from the carnivorous Asiatic wolves *(Canis lupus chanco)*[2]. Mitochondrial DNA analysis has showed that the closest relative of all domestic dogs is the Asiatic wolf. Therefore, the Asiatic wolf is most likely the ancestor of the modern domestic dogs[2,3]. The domestication of dogs was an important part of human history. It is not precisely known exactly when and why dogs were domesticated. The earliest verified dog remains (dating 12,000-11,000 years BP) was found buried in Israel together with human remains[4]. The ancestors of dogs may have initially come near human settlements to feed off the remains of the kills of the human hunter- gatherers. This probably led to the humans using the ancestral canids for hunting and guarding in exchange for food, leading to the formation of a close bond between the humans and the ancestral canids. Alternatively, the humans may have captured wolf pups and raised them. Most of the pups could have become aggressive as they grew older and thus were subsequently released into the wild. Occasionally a wolf pup was found to be friendly and remained with the humans even after it had become an adult. These canids could have been used for hunting and guarding which resulted in selection for traits that were important for these behaviours[3].

Evolutionary change towards better starch digestion

The humans gradually shifted from a nomadic hunter-gatherer to a sedentary agricultural lifestyle. With the shift in the lifestyle of the humans, there was a shift in the type of food offered to the ancestral canids. They were given a more starch rich diet in contrast to their previous protein rich diet[5]. This probably caused the ancestral dogs to undergo directional selection that targeted the gene Amy2B, increasing the gene's copy number in the dog population[6,7]. 60% of the wolf population bears only two copies of the Amy2B gene. During the process of domestication dogs have undergone nearly a seventeen fold increase in Amy2B gene copy number (34 copies)[6,7]. The Amy2B gene codes for pancreatic amylase which breaks down starch into maltose, thus enabling the canids to survive on a starch rich diet.

Current status of free-ranging dogs

Free-ranging dogs *(Canis lupus familiaris)* consist of unconfined dogs that found both in the cities and in rural areas. These dogs are generally stray dogs and are not under direct human supervision. They are present in all kinds of habitats where human settlements are found, from urban settlements to forest fringes. So, they are appropriately called free-ranging dogs[8]. Free ranging dogs are found in numerous countries around the world, including Japan, India, Mexico, Italy and some parts of Africa. These dogs are scavengers, living on the garbage produced by humans, in all habitations. Indian free ranging dogs live in an environment which is rich in starch based foods but poor in protein based foods. So, their diet consists mainly of carbohydrate (rice and wheat based foods) and relatively little protein (decomposing meat, garbage of meat shops etc.)[9]. They rarely hunt and so they do not get the chance to encounter any rich sources of protein[9]. As a result these dogs have become adapted to an omnivorous diet, which could be the result of the long process of dog domestication[10].

Objective of the experiment

The aim of the present experiment is to determine if there would be any behavioural changes if the adult dogs were provided with a carbohydrate rich diet or a protein rich diet.

II.RESEARCH METHODOLOGY

Study site

The study was conducted in Sukchar bazaar, Sodepur (22.41^0 N, 88.23^0 E), North 24 Parganas, West Bengal, India. The experimenter walked the streets and located the adult dogs. Ad-libitum observations were done to determine the daily activities, scavenging sites and resource availability of the dogs. Only adult dogs were selected for this study. All dogs that were near meat shops, restaurants or were regularly fed by humans were not selected for the experiment (as they had better access to protein foods). Pregnant dogs, lactating mothers or mother dogs with weaned pups were also not selected for the experiment. Dogs near busy roads were also not selected for the experiment (due to the increased risk of death by road accidents).

Sample size

40 adult dogs (16 males and 24 females) were selected for the experiment. The dogs were divided into two groups of 20 individuals (8 males and 12 females) each. One group was designated as the Carbohydrate group (Ca group) and the other group as Protein group (Pr group).

Procedure

The dogs of the Ca group were provided with 500g of cooked white rice (miniket) and the dogs of the Pr group were provided with 500g of raw minced chicken each day. The feedings were done in the morning (800-1000 hrs) and in the evening (1700-1900 hrs). The experiment was conducted for 120 days (1 January-30 April 2017). The experimenter conducted scan sampling (each of 5 min duration) in two sessions, morning session (1100-1300 hrs) and evening session (1930-2130 hrs).We had 5760 scan sample data. All recorded behaviour were divided into- Active behaviour and Passive behaviour (refer to table 1).

Table-1: Behaviours observed in scan sampling

Active Behaviour	Passive Behaviour
Chasing	Sleeping
Following	Dozing
Walking	Yawning
Running	Rolling over
Scavenging	Laying down
Digging	Sniffing
Fighting	Looking
Chewing	Panting
Eating	Barking
Drinking	Tail wagging
Begging for food	Urination
Jumping	Defecation
	Scratching
	Stretching leg
	Vomiting
	Watching
	Snarling
	Allogroming
	Raising head
	Shaking

Statistical analysis

We calculated the average time spend by the dogs on active and passive behaviours for both the Ca and Pr groups. We determined whether there was any difference in the amount of time spend on active and passive behaviours between the two groups. We also determined whether sex of the dog had any effect on the amount of time spend on active and passive behaviours. All statistical analysis was done using statistiXL v 1.8.

III.RESULTS AND DISCUSSION

The experiment showed that the dogs of both groups performed more passive behaviours than active behaviours (refer to figure 1 and 2) (Pr group- paired t test: T= 9.14, df=29, p<0.00001)

(Ca group-paired t test: T=5.81, df=29, p<0.000001)

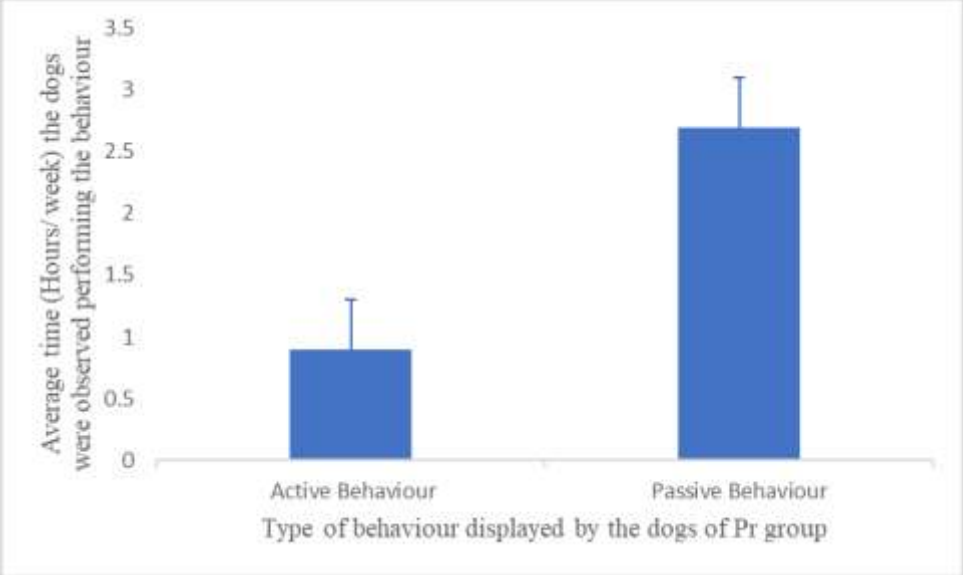

Figure-1: Average time spend by the dogs of Pr group performing active and passive behaviours

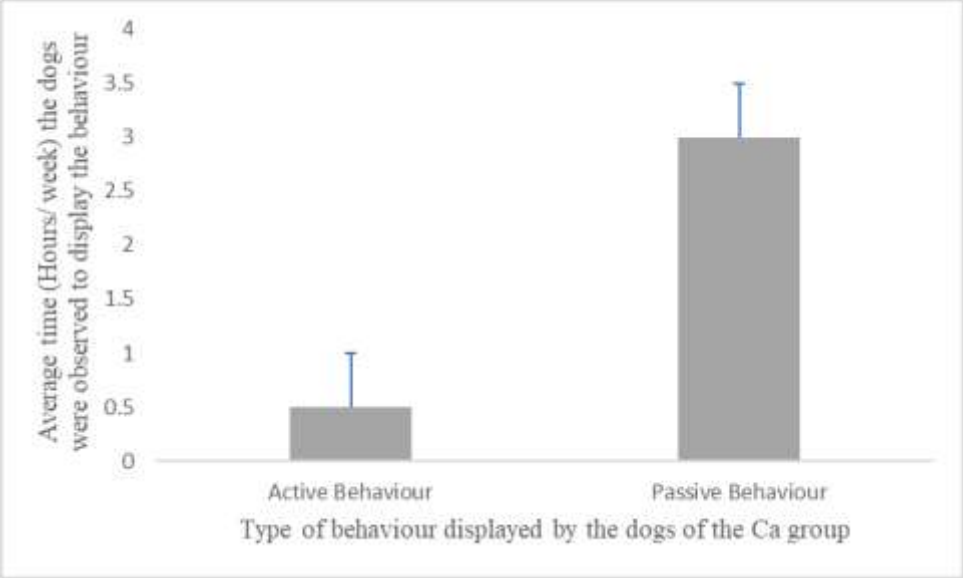

Figure-2: Average time spend by the dogs of Ca group performing active and passive behaviours

The experiment showed that dogs of the Pr group spend more time performing active behaviours than the dogs of Ca group (refer to figure 3)(unpaired t test: T= 5.72, df=29, p<0.00001)

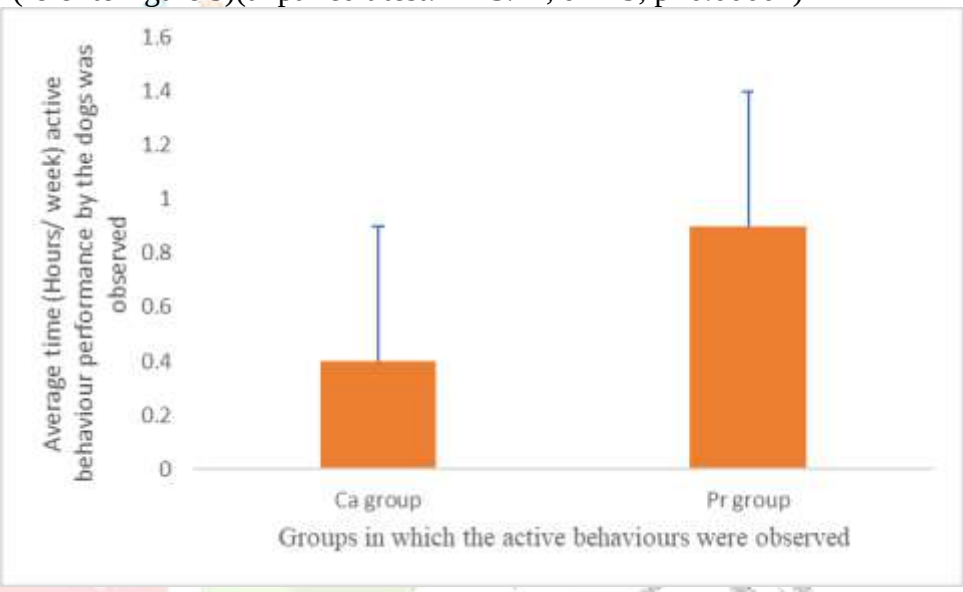

Figure-3: Average time spend by the dogs of the Ca and Pr groups in performing active behaviours

No significant difference was found in the time spend by the dogs of both groups in performing passive behaviours (refer to figure 4) (unpaired t test: T=0.604, df=29, p<0.5)

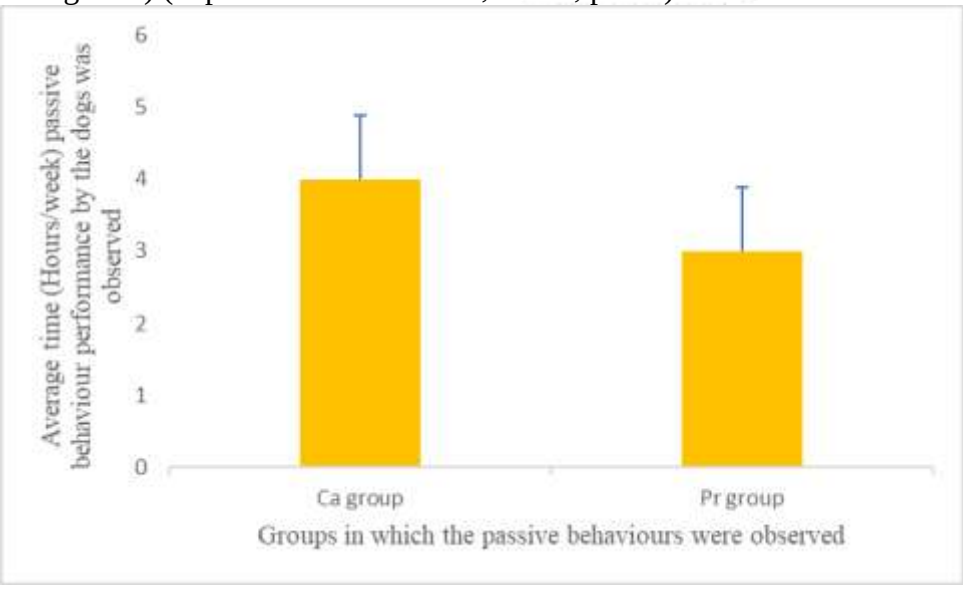

Figure-4: Average time spend by the dogs of the Ca and Pr groups in performing passive behaviours

There was no significant difference between the two sexes in the time spend performing active and passive behaviours (refer to figure 5 and 6) (Active behaviour-unpaired t test: T=0.66, df=11, p<0.5)
(Passive behaviour-unpaired t test: T= 1.29, df=11, p<0.1)

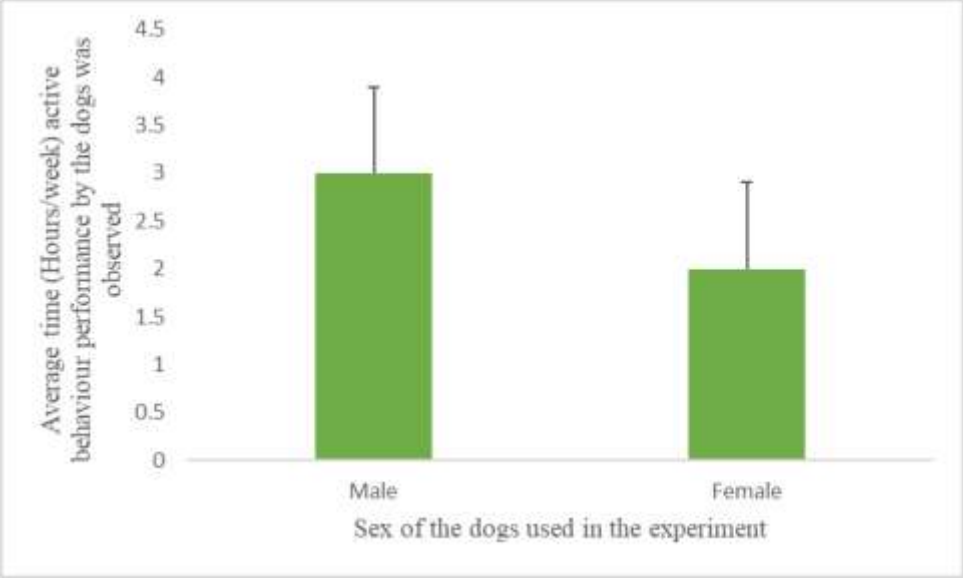

Figure-5: Average time spend by the dogs of both sexes in performing active behaviours

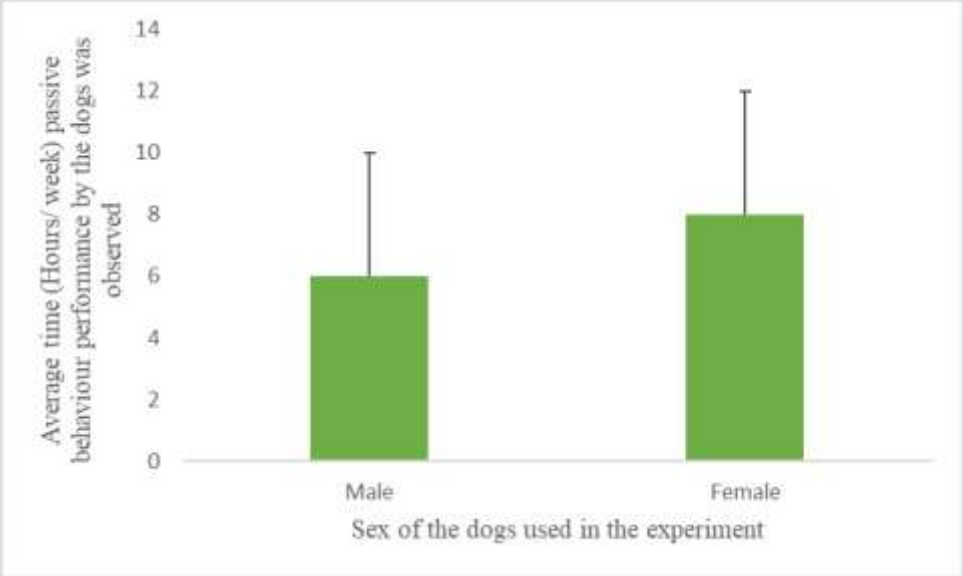

Figure-6: Average time spend by the dogs of both sexes in performing passive behaviours

Findings

1. The dogs spend more time performing less energy consuming passive behaviours
2. The protein diet enabled the dogs to acquire more energy than the carbohydrate diet enabling the dogs to perform more energy consuming active behaviours
3. The diet did not influence the time spend in performing passive behaviours
4. Sex of the dogs did not affect the time spend by the dogs in performing active and passive behaviours

Correlation with previous studies done on domestic dogs

Studies on Indian free-ranging dogs have shown that the dogs spend majority of their time (52.7%) of their time sleeping or lazing around[11]. There are ten essential amino acids which the dogs cannot make by themselves. They obtain these essential amino acids from their protein foods[12]. The protein foods also contain the carbon chains which the dog's body uses to make glucose. The glucose is then used as a source of energy. Studies on the diet of domestic dogs have shown that when dogs are allowed to self-select they prefer to consume 39-44% of their energy requirements from proteins, 53-58% from fats and only 3% from carbohydrate[13]. Studies on the performance of working dogs have shown that a diet consisting of high fat or high protein composition with no carbohydrate resulted in better stamina and less exhaustion for the dogs. A diet consisting of higher carbohydrate resulted in higher muscle glycogen content in dogs but the glycogen was found to be used up too rapidly resulting in poor stamina and quicker exhaustion for the dogs[14]. Studies on domestic dogs have shown that the dogs like wolves have a preference for protein over carbohydrate

based foods[15]. Indian free-ranging dogs are present in an environment rich in carbohydrate but poor in protein food sources[9]. They survive by scavenging for food from garbage dumping sites or by begging humans to give them biscuits or leftover rice. The dogs face fierce competition at the feeding sites (dumps, dustbins etc)[9]. Indian free-ranging dogs, having limited access to protein foods, may have difficulty obtaining these ten essential amino acids. These dogs have a tendency to consume any food items with a meat smell to get as much protein from their diet as possible[9].

IV.CONCLUSION

Indian free-ranging dogs prefer to conserve energy. In the urban environment where the dogs cannot be certain of their next meal avoiding unnecessary wastage of energy may enable them to survive longer. The dogs were able to get more energy from the protein diet than the carbohydrate diet. Despite undergoing evolutionary change to be able to better digest carbohydrate the dogs are not able to use carbohydrate as an efficient energy source as protein. Under normal circumstances that is when the female is not pregnant or lactating, both sexes are able acquire nearly same amount of energy from same type of food sources. Since the dogs are able to acquire more energy from the protein foods, the protein diet is better for the Indian free-ranging dogs. Availability of more protein food sources may enable the dogs to be able to better survive in the urban environment.

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