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Food preferences in Indian free-ranging dogs

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Abstract
Carbohydrates, proteins and fats are the three macronutrients needed by animals to survive. Although the dogs have descended from wolves they have undergone physiological changes to survive on starch based foods. Indian free-ranging dogs survive mainly on a starch based diet. Protein foods are only infrequently encountered by them. Animal fat based are almost never encountered by them. When given a choice between carbohydrate, protein and fat based foods the dogs showed a preference for protein based foods over the other two types of food. The dogs exhibited neophobia and preferred to consume the rarely encountered fat based food last. They also showed a preference for more familiar raw meat over the unfamiliar cooked meat. The sex of the dogs did not affect the food preference of the dogs.

Keywords: indian free-ranging dogs, food preference, neophobia, fat based food

1. Introduction
The three main macronutrients are carbohydrate, protein and lipid. Carbohydrates like glucose are the main sources of energy for all living organisms. Carbohydrates in the form of glycogen are stored in the muscles for future use as energy sources. Sugars like ribose and deoxyribose are components of RNA and DNA respectively. Enzymes are proteins that catalyse important biochemical reactions. Proteins are also needed for various immune responses, cell signalling, cell cycle and cell adhesion processes. Fats play an important role in body temperature maintenance, energy source, hair and skin health. 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]. Mitochondrial DNA analysis has shown that the closest living relative of the domestic dog *(Canis lupus familiaris)* is the Asiatic wolf *(Canis lupus chanco)* [2, 3]. The domestic dogs have probably descended from the carnivorous Asiatic wolf [2]. The domestic dogs have undergone various physiological changes during the process of domestication. One of these changes has enabled the domestic dogs to survive on starch rich diets in contrast to the protein rich diets of the carnivorous wolves. 60% of the wolf population bears only 2 copies of the gene Amy2B. During the process of domestication the dogs have undergone gene duplication of the Amy2B gene resulting in a nearly seventeen fold increase in the Amy2B gene's copy number [4, 5]. The Amy2B encodes pancreatic amylase that enables the dogs to digest starch based foods. Indian free-ranging dogs are unconfined dogs that are found in both urban and rural environment [6]. Free-ranging dogs are found in various cities around the World, including India [7], Italy, Japan, Mexico and some parts of Africa. Indian free-ranging dogs live mainly in an environment rich in starch based foods [8] but is limited in its availability of protein based foods. The dogs are dependent on the humans for their food supply but are not under direct human supervision. These dogs are found in all human habitats [6]. The dogs either live alone or in small groups [9]. Due to the scarcity of available food resources the dogs live by scavenging food from garbage and begging humans for food. Hostile interactions take place among the dogs at these garbage dumping sites [10]. The majority of the food encountered by the dogs is starch based. Protein foods are mainly obtained from meat shops in the form of chicken claws, intestines and pieces of skin. Animal fat food sources are not encountered by the dogs. During the process of domestication, the dogs have become adapted to an omnivorous lifestyle [11].

2. Materials and methods
The study was conducted in three different areas- Sukchar bazaar, Sodepur (22.41^0 N, 88.23^0 E), Khardah railway station, Khardah (22.72^0 N, 88.38^0 E) and Barrackpore chiriamore, Barrackpore (22.76^0 N, 88.37^0 E), North 24 Parganas, West Bengal, India. The experiment was done in two phases, first phase from 5th August 2016 to 10th August 2016 and second phase from 20th August 2016 to 24th August 2016. The experimenter walked the streets and provided the dogs with a multiple choice test for food selection. Different locations were selected to prevent the same dog from being used in the experiment twice. Each location was used for the experiment for only one day to further prevent the same animals from being used twice in the experiment. Only adult dogs were used in the experiment. Pregnant females, lactating mothers and females with weaned young pups were excluded from the experiment. In the first phase of the experiment, Barrackpore chiriamore and Khardah railway station was selected as the areas of study. At Khardah railway station, 20 adult dogs (9 males and 11 females) were selected for this phase. In this phase, 14g of raw minced boneless chicken and 14g of minced boiled chicken egg albumin were placed on circular paper plate (23.2 cm in diameter) 8cm apart and given to the dogs. The position of the two food types was changed for each dog. The order in which the two food types were eaten by the dogs was recorded. At Barrackpore chiriamore, 40 adult dogs (15 males and 25

females) were selected and divided into two groups of 20 individuals each. The first group (12 males and 8 females) were given 14g of raw minced boneless chicken and 14g of cooked minced boneless chicken on a paper plate, 8cm apart. The positions of the foods were again changed for each dog. The order in which the two food types were consumed was again recorded. For the second group (3 males and 17 females), 14g of cooked white rice (miniket) and 14g of broken biscuits (tea stall biscuits) were given to the dogs on a paper plate 8cm apart. The positions of the foods were changed for each dog and the order of consumption of each food item was recorded. The first phase was done to select the food items to be used as protein and carbohydrate food sources for the second phase of the experiment. Raw minced chicken as the protein source and cooked rice as the carbohydrate food source were selected for the second phase of the experiment. Cooked egg yolk was selected as the fat food source (we could not find any other easily available solid animal fat food source that was safe for the dogs) The second phase of the experiment was conducted in Sukchar bazaar, Sodepur. 40 adult dogs (22 males and 18 females) were selected for the experiment. 14g of raw minced boneless chicken, 14g of cooked rice and 14g of broken cooked egg yolk were placed on a paper plate 4cm apart. The positions of the food types were changed for each dog and the order of consumption of the different food types was recorded. We calculated the relationship between the food types used and the order in which the different food types were consumed by the dogs. We calculated the relationship between the sex of the dog and the order in which the food types were consumed by the dogs. All statistical analysis was carried out using statistiXL v 1.8.

2.1. Ethical note
The food used for this experiment was purchased and prepared fresh every day. No invasive techniques were used in this experiment.

3. Results
The experiment showed that the dogs preferred raw chicken over the egg albumin as a protein source (Chi-square test: χ^2 = 27.9164, df = 1, p< 0.00001) (refer to fig 1).

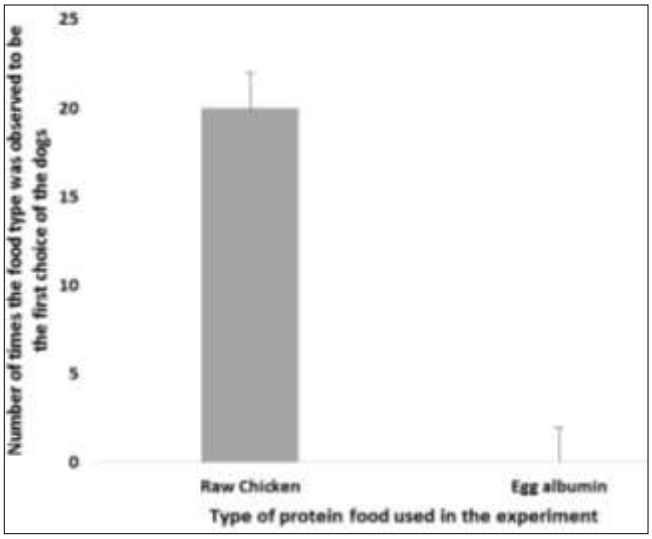

Fig 1: The type of protein food preferred by the Indian free-ranging dogs

The experiment showed that the dogs preferred raw chicken over cooked chicken (Chi-square test: χ^2 = 10.0251, df = 1, p< 0.001544) (refer to fig 2).

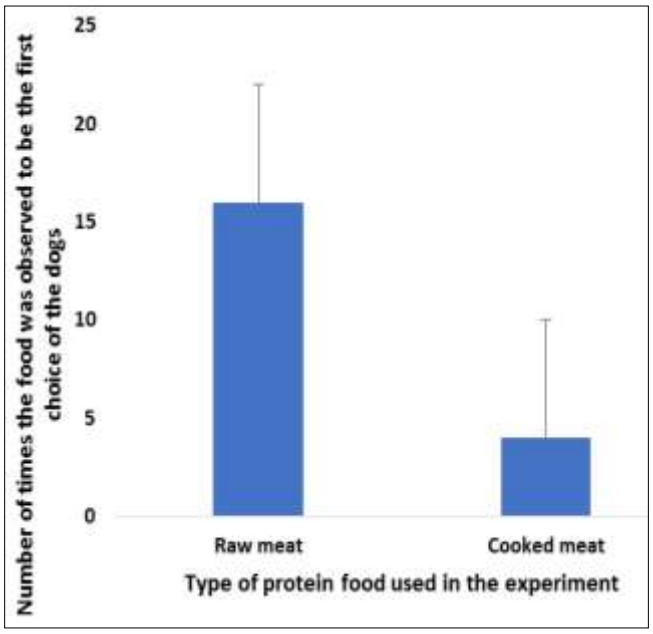

Fig 2: The type of chicken meat preferred by the Indian free-ranging dogs as the protein food source

No particular preference for any one food item (cooked rice or tea stall biscuits) over the other was observed among the dogs for the carbohydrate food sources (Chi-square test: χ^2 = 0.0677, df =1, p< 0.796253) (refer to fig 3).

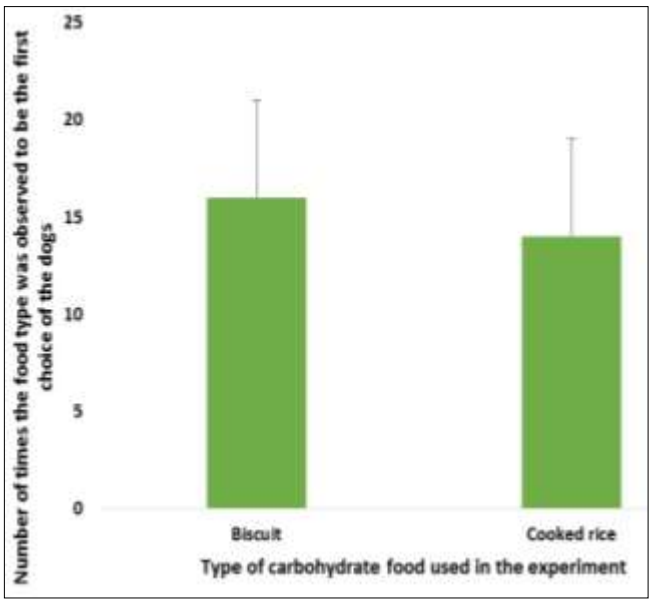

Fig 3: The type of food preferred by the Indian free-ranging dogs as the carbohydrate food source

The dogs preferred protein food over the carbohydrate and fat food sources. The carbohydrate food source was preferred over the fat food source (Chi-square test: χ^2 =123.7236, df = 4, p< 0.00001) (refer to fig 4).

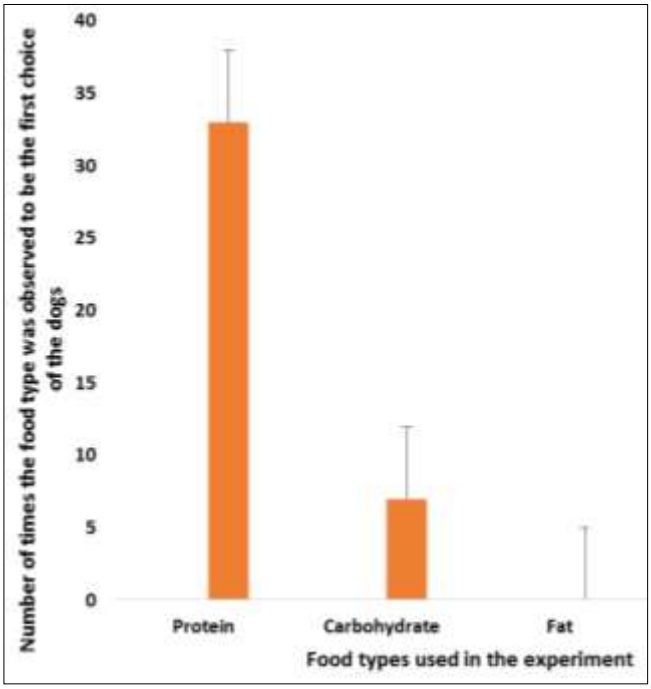

Fig 4: Food preference of Indian free-ranging dogs

There was no significant difference in the type of food chosen by the dogs between the two sexes (Chi-square test: $\chi^2 = 0.5403$, df = 2, p< 0.763263) (refer to fig 5).

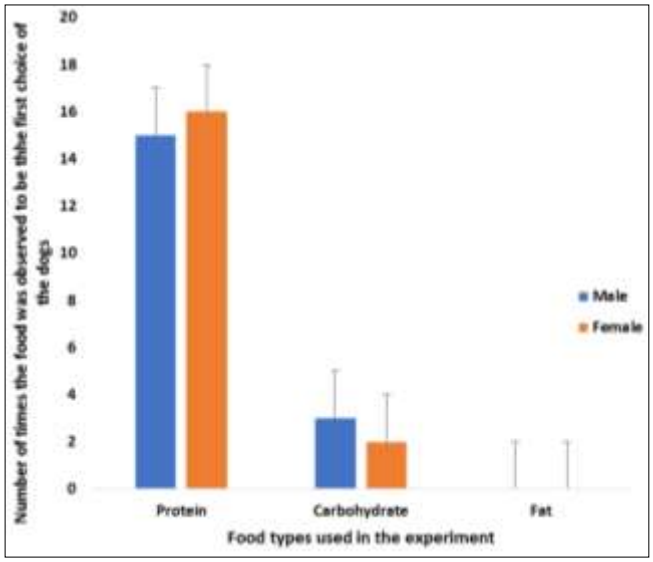

Fig 5: The effect of sex on food preference in Indian free-ranging dogs

4. Discussion

Dog domestication began during the Upper Palaeolithic period (35000yrs before present) [1]. The domestication probably began when humans kidnaped wolf pups and raised them. If pups became hostile when they became adults then they were released into the wild. If they remained friendly as adult animals then they remained with their human family members. The wolves could also have come near human settlements to feed on human kills. These wolves helped the humans in hunting larger animals and also guarded the human families in exchange for food [3].

When the humans shifted to sedentary agricultural lifestyle the dogs were given more starch based foods in contrast to their previous protein rich diet. This situation caused the dogs to undergo directional selection that increased the gene copy number of the Amy2B gene [4, 5]. The Amy2B gene codes for pancreatic amylase which breaks down starch into maltose, thereby enabling the dogs to survive on a starch rich diet.

Dietary proteins contain 10 amino acids, known as essential amino acids, that the dogs cannot make on their own. These amino acids provide the building blocks for many important proteins and biologically active compounds. The dietary proteins also donate the carbon chains needed to form glucose for energy. Dietary fats that are derived mainly from animal sources provide the most concentrated source of energy for the dogs. The dietary fats also provide the dogs' with essential fatty acids that the dogs cannot make on their own. These essential fatty acids serve as the carriers for important fat soluble vitamins. The essential fatty acids play an important role in cell structure and function. These fatty acids are also needed for keeping the dog's coat and skin healthy. Dietary fats also help to improve the taste of the foods. Deficiencies in the 'omega-3' family of fatty acids may lead to vision problems and impaired learning abilities. Deficiencies in 'omega-6' family of fatty acids may lead to various physiological problems in the dog's body [12]. In dogs fat oxidation provides the maximum amount of energy during energy expenditure. The amount of energy released during fat oxidation in dogs is twice the amount released in humans. Albumin binds more free fatty acids in dogs, thereby increasing the fatty acid concentration in the blood of the dogs. This situation increases the delivery of fatty acids to the tissues of the dogs. The muscle fat and glycogen stores are higher in dogs than in humans. A high fat and low carbohydrate diet resulted in better stamina for the dogs. A high fat or high protein diet in working dogs resulted in less exhaustion and better performance for the dogs. A high carbohydrate diet resulted in higher muscle glycogen content for the dogs but also resulted in quicker exhaustion and poor stamina for the dogs as the glycogen was observed to be quickly used up [13]. Studies on dogs diets have shown that when dogs were allowed to self-select, the dogs choose 30-44% of their energy requirements from proteins, 58-67% from fats and only 3% from carbohydrates [14]. These studies were done on pet dogs over long periods of time, enabling the dogs to get accustomed to the diets. In this experiment it was found that the dogs chose the fat based food (egg yolk) last. The free-ranging dogs normally do not encounter any animal fat based foods in their lifetime. The wariness towards the fat based food could be due to lack of familiarity with that type of food in the dogs' everyday life. Studies on domestic dogs have shown dogs to exhibit neophobia regularly in regards to novel sources of food [15]. Studies on the behaviour of pet dogs have shown that the dogs prefer the type of food they were given during the first six months of their lives. They are slow to accept any new food items that they are not familiar with, even if their previous diet has been completely stopped [16]. Studies on Indian free-ranging dogs have shown that the adult dogs prefer to consume any food with a meat smell to get as much protein in their diet as possible [8]. Studies have shown that despite the process of domestication, dogs like wolves prefer meat over carbohydrate based foods [17]. Neophobia could explain the reason why the free-ranging dogs choose mainly raw meat which they are familiar with over the cooked meat which was rarely encountered by them in their everyday lives.

Neophobia also explains why the dogs never chose the egg albumin, which was probably never encountered by them before the experiment, as their first choice. In case of the carbohydrate food sources, both the cooked rice and tea stall biscuits were frequently eaten by the dogs in their everyday lives. The two carbohydrate food sources where chosen as the first choice with equal frequency. The experiment showed that sex did not affect the type of food chosen by the dogs. Studies on food preferences of intact males and females have shown that unless the females are pregnant or lactating, sex does not affect food choice in domestic dogs [18]. In an environment where the dogs cannot be certain of the source and safety of new food items it is safer for the dogs to eat only the food items that they have consumed before and were known to be safe.

5. Conclusion

Indian free-ranging dogs prefer to consume food items that they are familiar with instead of novel food items. Unless the dogs are in a state of high energy requirement sex does not influence the types of food consumed by the dogs. In the urban environment where the dogs' main source of food is from garbage, avoiding unfamiliar food items may enable the dogs to reduce their chances of consuming inedible, unsafe or contaminated foods which could make the dogs sick or even kill them. This practice of neophobia in case of food consumption could help the dogs to remain safe and live longer in the urban environment.

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