Indian Journal of Ecology (2022) 49(5): 1642-1646
DOI: https://doi.org/10.55362/IJE/2022/3709

Manuscript Number: 3709
NAAS Rating: 5.79

Probiotic Manipulation of the Gut Ecosystem and its Impact on Body Condition Score in the Asian Elephant

Dharmendra Chharang and Sheela Choudhary

Department of Animal Nutrition, Post Graduate Institute of Veterinary Education and Research
Rajasthan University of Veterinary and Animal Sciences, Jaipur-302 031, India
E-mail: dchharang@gmail.com

Abstract: A study was carried out to evaluate the effect of dietary manipulation of the gut ecosystem by supplementing probiotics on body condition score (BCS) in 18 captive female Asian elephants of 30-62 years age for a period of two months. The elephants were randomly divided into three groups, with six each. The control group, in which the elephants received basal feed without any probiotic supplements, whereas the elephants of the group 2, and the group 3 were, fed a similar basal feed along with oral powdered probiotics, i.e.*Lactobacillus acidophilus* and *Saccharomyces cerevisiae* @ 1 gm 1 × 10^9 cfu/gm for every 50 kg BW/day each, respectively. An overall visual evaluation based BCS on a 5-point scale was taken once at the end of the study.The statistical analysis of the data did not reveal any significant effect of the treatments. The overall mean BCS was 3.78 and showed a tendency toward fat condition. Total 77.78 and 22.22% elephants had BCS-4 and BCS-3, respectively. No elephants had BCS-1, 2, and 5. In conclusion, supplementation of probiotics did not affect the body condition score and exhibited a good maintenance of the nutritional status.

Keywords: Asian elephant, Body condition score, Probiotic manipulation, Gut ecosystem

The Asian elephant (*Elephas maximus*) is the continent's largest terrestrial, intelligent, social and long-ranging endangered migratory animal. The species has been listed in the IUCN Red List of Threatened Species due to decline in population size by approximately 50 per cent over three generations (Choudhury et al 2008, CMS COP13 2020). Based on the recommendation of the Elephant Task Force, India has declared Indian Elephant as “National Heritage Animal” (Rangarajan et al 2010). It provides the highest degree of legal protection under Schedule I of Wildlife (Protection) Act, 1972. For the conservation of the elephant species globally, the Association of Zoo and Aquariums Elephant Taxon Advisory Group/ Species Survival Plan Management Committee have endorsed research to better understand causes of poor health, nutritional and welfare issues of elephants (Keele and Ediger 2011). For these issues, obesity might be the prime suspected reason (Clubb et al 2008). The condition of an animal is primarily a reflection of fat reserves which in turn are generally assumed to determine an individual's nutritional and habitat status (Ramesh et al 2011). Body condition scoring is a reasonable alternative to direct measurement of chemical composition. It provides an index of the energy stored as fat and muscle and is a quick reliable means of identifying extremes in manage mental and nutritional welfare approaches used for the animals. Assessment of body condition score (BCS) is individual based that does not require a high technical skill and comparatively inexpensive as well as meaningful when applied to a large wild population like elephants (Fernando et al 2009). This is one of the important tools in the elephant management, whether in captivity or in the wild (Wijeyamohan et al 2014).

The gastrointestinal tract harbours a complex community of microbiota, and it plays a pivotal role in health and wellbeing of animals. Any manipulation in diet can rapidly change the microbial community in the gut, as the gut ecosystem strongly contributes to animal physiology (Bruni et al 2020). Various strategies have been developed to maintain gut ecosystem with the growing concerns about using antibiotics and other growth stimulants (Chharang et al 2021). Probiotics could be a potential strategy to successfully exhibit the effect of the microbes on gut function, and it is considered to be important in treatment of obesity along with significant reductions in body mass index, body weight and fat mass (John et al 2018) as well as better nutrients utilization resulted in improved health performance and nutritional status (Anee et al 2021). Thus, an attempt was made to evaluate the effect of dietary manipulation of the gut ecosystem by supplementing probiotics on body condition score (BCS) in Asian elephants.

MATERIAL AND METHODS

Ethical statement: The study was carried out with the prior permission of the Additional Principal Chief Conservator of

Forest and Chief Wildlife Warden, Government of Rajasthan, Jaipur (India). The study protocol was duly approved by the Institute Animal Ethics Committee (PGIVER/IAEC/I9-05) and performed in accordance with relevant guidelines and regulations for care and management (MoEF and CC 2008).

Study area: The present study was undertaken during the monsoon season at Elephant Village, Jaipur (India), which is located at latitude 26° 59'47" N, longitude 75° 52'35" E and altitude of 431 meters above the sea level.

Study animals: Eighteen healthy, captive adult female Asian elephants of 30 to 62 years age and alike BW (3495 ± 133.34 kg) were selected and stall-fed a consistent feed of green pearl millet forage commonly known as bajra as basal feed throughout the research period of 60 days. An adaptation period of 10 days was observed prior to start of experimental feeding trial. Thereafter, the selected elephants were divided into three similar groups of six elephants each in such a way that each group had almost similar average body weight.

Table 1. Experimental feeds offered to Asian elephants in different groups

Experimental groups	Experimental feed
T_1	Green pearl millet forage as basal feed (without probiotic)
T_2	Green pearl millet forage + *Lactobacillus acidophilus* @ 1 gm 1 × 10^9 CFU/ 50 kg body weight per day
T_3	Green pearl millet forage + *Saccharomyces cerevisiae* @ 1 gm 1 × 10^9 CFU/ 50 kg body weight per day

Feeding of experimental probiotics: The elephants were then placed on three dietary experimental feeds for 50 days of experimental feeding trial (Table 1). All the elephants were housed in a hygienic and well ventilated individual enclosure, with a separate feeding arrangement.

Data collection: Body condition score (BCS) is an index of an animal's health. The BCS of all elephants were assessed by using a method described by Baarlen and Gerritsen (2012), Morfeld et al (2014) and Pokharel et al (2017). An overall score on a 5-point scale, with 1 representing the lowest and 5 representing the highest body fat level was used (Table 2, Fig.1) (Pokharel et al 2017). The BCS-3 was considered ideal for the animal. The BCS assessment in this study was based on visual evaluation and scoring of subcutaneous fat stores of the body parts, including bony structures such as pelvic girdles, pectoral girdles, skull, ribs, backbone, and any depressions as shown in Figure 2 (Wijeyamohan et al 2014). The BCS was taken once at the end of the experiment, in the morning before the elephants received their first meal.

Table 2. BCS index used for the experimental Asian elephants

BCS	Head	Ribs	Backbone	Shoulder	Hind quarter
1. Very thin	Entire head looks hollowed and highly sculpted, bones were easily visible, hollow behind the ears, division between head and body easily visible	Very prominent and easily visible	Prominent from tailhead to shoulders, deep depression alongside backbone in lumbar region	Emaciated, shoulder blades clearly visible. No muscular fat visible	Pelvis clearly visible, deep depression in front and behind pelvis. Prominent tailhead
2. Thin	Head had sculpted appearance, bones were easily visible, hollowed behind the ears and under the eyes	Prominent and appeared to be covered by a thin fat layer	Clearly visible from tailhead to mid-back, depression alongside backbone in lumbar region	Shoulder blades visible. A slender body	Pelvis clearly visible, a gradual sunken area in front and flattened area behind pelvis, flat tailhead
3. Moderate	Bones on the head were clearly visible, but no hollowed areas	Not visible	Visible from tailhead to mid-back, sloping alongside backbone in lumbar region	Shoulder blades visible during movement	Pelvis visible as a ridge, entire pelvis may not be visible, slight sunken or flattened area in front and/or behind pelvis, moderate fat around tailhead
4. Fat	Rounded head, little sculpting evident, division between head and body not easily visible	Not visible	Visible as a ridge from tailhead to mid-back, no apparent depression and fat began to accumulate alongside backbone in lumbar region	Not visible, fat deposits evident	Pelvis not visible, fat around tailhead, hips rounded
5. Obese	Rounded head, bones hardly visible, division between head and body not easily visible	Not visible	Difficult to differentiate, may be visible from tailhead to pelvic bone region and appeared to be covered with thin fat layer, area in lumbar region filled in	Not visible, fat deposits extremely evident	Pelvis not visible,excessive fat around tailhead, hips, and pelvic bones very rounded, rotund

Statistical analysis: The experimental data were subjected to statistical analysis (SPSS version 24).

RESULTS AND DISCUSSION

All the elephants were healthy throughout the study, and no side effects of probiotics supplementation in both the groups were recorded. No change in feed consumption was recorded. A summary for the effect of dietary supplementation of probiotics *Lactobacillus acidophilus* and *Saccharomyces cerevisiae* on body condition score is presented in Table 3. The overall mean was 3.78. The BCS results revealed that 14 out of 18 elephants (77.78%) and 4 out of 18 (22.22%) had BCS-4 and BCS-3, respectively. No elephants had BCS-1, 2, and 5. The statistical analysis of the data did not reveal any significant effect of the treatments.No difference in BCS between control and probiotic groups for the whole study period was recorded.

There were no statistical differences (regarding the body condition score (BCS) in the Asian elephants of different groups. The overall BCS recorded to be higher side and the trend of BW and BCS revealed that all the elephants were in good condition but showed a tendency toward fat condition. The possible reason for the higher body condition score might be linked to overfeeding of large quantity of readily available energy feedstuffs and lesser energy expenditure due to the captive nature of elephants throughout the year. All the elephants in the treatment groups maintained their BCS score throughout the trial compared to the control group. The results exhibited good maintenance of the nutritional status in elephants that were prone to overweight, meaning that even in healthy elephants with no gastrointestinal disorder the addition of these supplements to the diet helps to maintain the optimal balance of their intestinal microbiota.

Overfeeding and obesity are common problems mentioned in the literature on zoo animal nutrition in herbivores (Ange et al 2001, Hatt and Clauss 2006). It has long been a concern that zoo elephants are 'obese' (Clubb et al 2008). Based on BCS measures, a survey confirmed that, over 65 and 56% of adult Asian elephants are obese in North American and European zoos, respectively (Morfeld et al 2016, Schiffmann et al 2018). Elephants under captivity appear to have higher BCSs (Schiffmann et al 2018) and greater body mass compared with wild elephants (Schiffmann et al 2019). Being the intestinal microbiota involved in the regulation of fat storage, the feeding of probiotics could have positive metabolic effects in the prevention and treatment of fat and obese conditions in animals (Miyoshi et al 2014, John et al 2018).

In agreement with the result of present study, Lehloenya et al (2008), Al Ibrahim et al (2010) in dairy cows, Rossi et al

Table 3. Mean values of BCS in different groups

Groups	Name of elephant	Reg. No.	Age (yrs)	Body Wt. (kg)	BCS	Mean BCS
T_1	Jaimala	11	41	3018	4	3.83 ± 0.17
	Rajrani	20	56	3000	3	
	Phoolwanti	116	30	3594	4	
	Jhomati	53	48	3900	4	
	Chameli	123	44	3324	4	
	Jaytara	92	45	4116	4	
T_2	Laxmi	125	47	3000	3	3.67 ± 0.21
	Laxmi	130	52	2964	4	
	Anno	93	48	3234	4	
	Tami	109	35	3702	3	
	Gomati	81	33	3864	4	
	Shobha	96	40	4080	4	
T_3	Bhogwati	30	49	2658	4	3.83 ± 0.17
	Champa	105	33	3180	4	
	Rangoli	43	44	3900	4	
	Majani	55	50	3684	3	
	Champakali	52	50	3936	4	
	Chanchal	9	62	4620	4	

BCS-4 =77.78%; BCS-3 = 22.22%; BCS-1=Nil; BCS-2=Nil; BCS-5=Nil, overall BCS=3.78 ± 0.10
P-value=0.761

(2020) in dogs and Sri Lekha et al (2021) in Murrah buffalo calves, showed non-significant effects of probiotics on body condition score. Contrary to results of this study, Bruni et al (2020) and Marelli et al (2020) showed significantly lower and higher BCS in probiotics supplemented dogs, respectively.

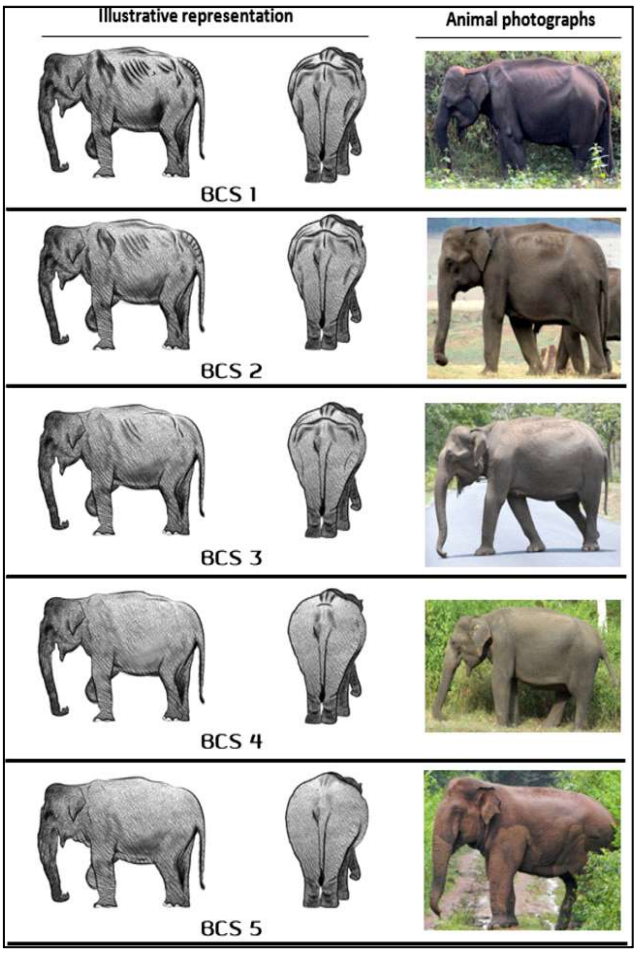

Fig. 1. Representative schematic and photographic illustrations of elephant showing body conditions with assigned BCS values, ranging from 1 to 5

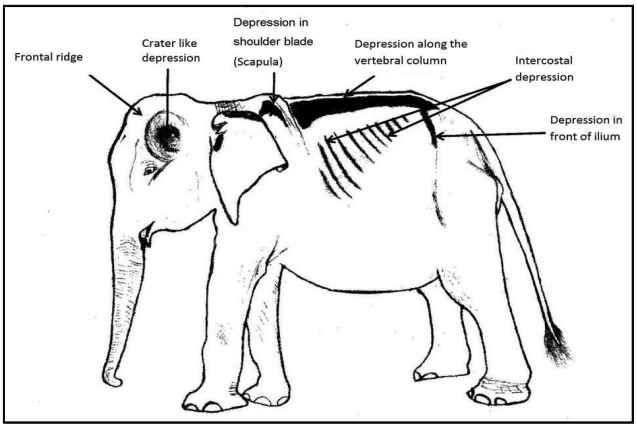

Fig. 2. Sketch of emaciated elephant showing all the depressions, bones, and spines

CONCLUSION

Dietary supplementation of probiotics *Lactobacillus acidophilus* and *Saccharomyces cerevisiae* did not affect the body condition score and exhibited a good maintenance of the nutritional status. Probiotics were supplemented at the recommended dosage, but perhaps it was not enough to make a difference in healthy elephants. Further studies are needed to increase the dose rate and test the long term probiotic effects on BCS in healthy elephants.

REFERENCES

Al Ibrahim RM, Kelly AK, O'Grady L, Gath VP, McCarney C and Mulligan FJ 2010. The effect of body condition score at calving and supplementation with *Saccharomyces cerevisiae* on milk production, metabolic status, and rumen fermentation of dairy cows in early lactation. *Journal of Dairy Science* **93**(11): 5318-5328.

Anee IJ, Alam S, Begum RA, Shahjahan, RM and Khandaker, AM 2021.The role of probiotics on animal health and nutrition. *The Journal of Basic and Applied Zoology* **82(**52), https://doi.org/10.1186/s41936-021-00250-x

Ange K, Crissey SD, Doyle C, Lance K and Hintz H 2001. A survey of African (*Loxodanta africana*) and Asian (*Elephas maximus*) elephants diets and measured body dimensions compared to their estimated nutrient requirements. *AZA Nutrition Advisory Group conference on Zoo and Wildlife Nutrition,* September 19-23, 2001, Florida, pp.5-14.

Baarlen IV and Gerritsen M 2012. *Elephant nutrition in Dutch zoos*. Ph.D. Dissertation, University of Applied Sciences, Netherlands.

Bruni N, Martello E, Fusi E, Meineri G and Giardini A 2020. Study of faecal parameters and body condition in dogs with a diet supplemented with *Lactobacillus acidophilus* D2/CSL (CECT 4529). *Italian Journal of Animal Science* **19**(1): 704-711.

Chharang D, Choudhary S and Bhatt L 2021. Assessment of blood metabolites, serum enzymes, and serum minerals in dietary probiotics fed captive Asian elephants. *Turkish Journal of Veterinary and Animal Sciences* **45**: 133-138.

Choudhury A, Lahiri Choudhury DK, Desai A, Duckworth JW, Easa PS, Johnsingh AJT, Fernando P, Hedges S, Gunawardena M, Kurt F, Karanth U, Lister A, Menon V, Riddle H, Rübel A and Wikramanayake E 2008. *Elephas maximus*. The IUCN Red List of Threatened Species 2008: e.T7140A12828813.

Clubb R, Rowcliffe M, Lee P, Mar KU, Moss C and Mason GJ 2008. Compromised Survivorship in Zoo Elephants. *Science* **322**(5908): 1649-1649,

CMS COP-13 2020. The Thirteenth Meeting of the Conference of the Parties to the UN Convention on Migratory Species, India. URL: https://europeansting.com/2020/02/24/ten-new-migratory - species-protected-under-global-wildlife-agreement.

Fernando P, Janaka HK, Ekanayaka SKK, Nishantha HG, Pastorini J 2009. A simple method for assessing elephant body condition. *Gajah* **31**: 29-31.

Hatt JM and Clauss M 2006. Feeding Asian and African elephants *Elephas maximus* and *Loxodonta africana* in captivity. *International Zoo Yearbook* **40**: 88-95.

John GK, Wang L, Nanavati J, Twose C, Singh R and Mullin G 2018. Dietary alteration of the gut microbiome and its impact on weight and fat mass: A systematic review and meta-analysis. *Genes* **9**(3): 167.

Keele, M and Ediger, ND 2011. *AZA Elephant Master Plan*. AZA

publication number 1999 10285. Zooe. Portland.

Lehloenya KV, Stein DR, Allen DT, Selk GE, Jones DA, Aleman MM, Rehberger TG, Mertz KJ and Spicer LJ 2008. Effects of feeding yeast and propionibacteria to dairy cows on milk yield and components, and reproduction. *Journal of Animal Physiology and Animal Nutrition* **92**: 190-202.

Marelli SP, Fusi E, Giardini A, Martino PA, Polli M, Bruni and Rizzi R 2020. Effects of probiotic *Lactobacillus acidophilus* D2/CSL (CECT 4529) on the nutritional and health status of boxer dogs. *Veterinary Record,* doi:10.1136/ vetrec-2019-105434

Miyoshi M, Ogawa A, Higurashi S, Kadooka Y 2014. Anti-obesity effect of *Lactobacillus gasseri* SBT2055 accompanied by inhibition of pro-inflammatory gene expression in the visceral adipose tissue in diet-induced obese mice. *European Journal of Nutrition* **53**(2): 599-606.

MoEF and CC 2008. *Guidelines for Care and Management of Captive Elephants.* Ministry of Environment, Forest and Climate Change, Government of India, New Delhi, p 61-72.

Morfeld KA, Meehan CL, Hogan JN, Brown JL 2016. Assessment of Body Condition in African (*Loxodonta africana*) and Asian (*Elephas maximus*) Elephants in North American Zoos and Management Practices Associated with High Body Condition Scores. *PLoS One* **11**(7): e0155146.

Morfeld KA, Lehnhardt J, Alligood C, Bolling J and Brown JL 2014. Development of a body condition scoring index for female African elephants validated by ultrasound measurements of subcutaneous fat. *PLoS One* **9**(4): e93802.

Pokharel SS, Seshagiri PB and Sukumar R 2017. Assessment of season-dependent body condition scores in relation to faecal glucocorticoid metabolites in free-ranging Asian elephants. *Conservation Physiology* **5**(1): cox039.

Ramesh T, Kalle R, Sankar K and Qureshi Q 2011. Assessment of wild Asiatic elephant (*Elephas maximus indicus*) body condition by simple scoring method in a tropical deciduous forest of Western Ghats, Southern India. *Wildlife Biology in Practice* **7**(2): https://doi.org/10.2461/WBP.2011.7.17

Rangarajan M, Desai A, Sukumar R, Easa PS, Menon V, Vincent S, Ganguly S, Talukdar BK, Singh B, Mudappa D, Chowdhary S and Prasad AN 2010. *Gajah. Securing the Future for Elephants in India.* The Report of the Elephant Task Force, Ministry of Environment and Forests, New Delhi.

Rossi G, Pengo G, Galosi L, Berardi S, Tambella AM, Attili AR, GavazzaA, Cerquetella M, Jergens AE, Guard BC, Lidbury JA, Stainer JM, Crovace AM and Suchodolski JS 2020. Effects of the Probiotic Mixture Slab51® (SivoMixx®) as Food Supplement in Healthy Dogs: Evaluation of Fecal Microbiota, Clinical Parameters and Immune Function. *Frontiers in Veterinary Science* **7**, doi:10.3389/fvets.2020.00613

Schiffmann C, Clauss M, Fernando P, Pastorini J, Wandler P, Ertl N, Hobys S and Hatt JM 2018. Body condition scores of European zoo elephants (*Elephas maximus* and *Loxodonta africana*): Status quo and influencing factors. *Journal of Zoo and Aquarium Research* **6**:91-103.

Schiffmann C, Clauss M, Hoby S and Hatt JM 2019. Weigh and see-Body mass recordings versus body condition scoring in European zoo elephants (*Loxodonta africana* and *Elephas maximus*). *Zoo Biology* **39**: 97-108.

Sri Lekha M, Seshaiah CV, Ashalatha P and Raja Kishore K 2021. Effect of Probiotic, Prebiotic and Synbiotic Supplementation on Growth Performance in Murrah Buffalo Calves. *International Journal of Current Microbiology and Applied Sciences* **10**(5): 280-287.

Wijeyamohan S, Treiber K, Schmit D and Santiapillai C 2014. A visual system for scoring body condition of Asian elephants (*Elephas maximus*). *Zoo Biology* **34**: 53-59.

Received 30 June, 2022; Accepted 15 September, 2022