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Research article

Enhancing Japanese visitors' interest in livestock welfare through zoo carcass feeding activities

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Abstract

Japanese people have little interest in livestock welfare. This study aimed to enhance their interest by implementing an educational programme in a zoo through two different types of carcass-feeding activities to encourage a personal connection between visitors and animals. Observers of jaguars *Panthera onca* being fed carcasses of laying hens (YouTube™ streaming: 27 August 2021; exhibit: 13 October–3 November 2021) showed significantly less concern for the husbandry environment of laying hens than the control group, even though the observers were highly conscious of animal welfare. There is a clear bias in the subject of visitors' animal welfare concerns. Participants who watched the streamed video before viewing the exhibit were not considerably different from control group visitors. At this point, there was no difference in the price of eggs purchased between these groups. In a post-event survey conducted three months later, the exhibit participants were as interested in the hens' husbandry environment as the non-exhibit participants and the price of eggs purchased was significantly higher than that of the non-exhibit participants. Thus, interest in hen welfare was maintained and welfare-oriented eggs were selected, which likely resulted in higher egg purchase prices. However, since this study is based on respondents' self-reports, it is unclear whether respondents' egg purchase prices actually increased. The carcass-feeding exhibit is thought to have at least broadened the zoo visitors' interest in livestock welfare. The provision of knowledge on hen care and management and the first-hand experience of gaining empathy for the animals were considered effective in making this change. Continued implementation of educational programs will be necessary to increase the number of visitors who are interested in the welfare of hens, to increase egg purchase prices, and ultimately to improve the environment in which hens are kept.

Introduction

The sustainability strategy issued by the World Association of Zoos and Aquariums (WAZA 2020) includes a proposal to educate people about proper livestock husbandry. Similarly, WAZA's Welfare Strategy (Barongi et al. 2015) calls on its members to "become a recognised centre for animal welfare expertise and assist and advise other organisations on animal welfare". The authors of this paper believe that this should also apply to livestock rearing facilities. In other words, for a zoo to become recognised as a centre of animal welfare expertise, they should also be improving local livestock welfare and educating visitors about livestock welfare.

The implementation of carcass feeding in zoos is thought to result in longer exhibit hours, positive attitudes toward animal welfare activities in zoos (Roth et al. 2017) and increased visitor motivation to view the exhibits (Gaengler and Clum 2015). In Japan, there are examples of carcass feeding using wild deer and boars that have been exterminated as pests (Hosoya et al. 2019). In this programme, visitors learn about zoo animal welfare and wildlife issues through explanation of feeding these carcasses and visitor interest in such issues increases. In this way, feeding carcasses at the zoo helps improve the living environment of the zoo animals and educates visitors.

In conservation education in zoos, it has been shown that building a personal connection between visitors and animals induces conservation behaviour. However, the target is limited to the animal with which the connection is formed (Grajal et al. 2017). Could this personal connection that visitors already form with zoo animals be converted into awareness of the welfare

of other animals? In the current study, live and social media video streaming of carcass feeding to carnivores was trialled as a means to translate personal connections made by zoo visitors with a particular animal to other animals. Using social media to encourage positive behaviour change has been demonstrated as effective and the number of views of a specific subject increases the viewer's understanding of the importance of the issue (Spartz et al. 2017). Carcass feeding in zoos also improves the foraging environment of carnivores and attracts the attention of zoo visitors.

The adoption of welfare-based rearing methods for laying hens in Japan has been slow with 92% of egg-laying chicken breeding systems in Japan using conventional cages according to a survey by JLTA (2014). It is estimated that the cost of hens' eggs will increase as animal welfare considerations are incorporated into poultry farming in Japan in the future (Kato et al. 2022). The dissemination of livestock welfare information to consumers in Japan has been slow and research on livestock welfare and Japanese consumer behaviour indicates that consumers' knowledge and experience of and empathy for livestock influence their consumption behaviour (Kitano et al. 2022; Washio et al. 2019). Hence, zoo educational activities that create empathy for the animals among visitors may be effective as part of the promotion and awareness of livestock welfare in Japan. Therefore, this study examined whether zoo exhibits can contribute to improving consumer interest in livestock welfare, specifically of laying hens, in Japan.

Educational activities could be conducted by exhibiting improved welfare methods of keeping laying hens. However, keeping hens in zoos is a challenge due to outbreaks of avian influenza caused by migratory birds. For epidemic control, all bird-keeping facilities must avoid contact with wild birds and thorough disinfection must be performed when entering and leaving animal housing (Moriguchi et al. 2021). Infected individuals are killed to control outbreaks. Outbreaks have occurred in zoos, where several birds have been culled (Usui et al. 2020). Because of these costs and risks, keeping hens in Japanese zoos is challenging. Therefore, it is considered necessary to take indirect methods to improve consumer interest in laying hens' welfare.

As mentioned above, social media video streaming and carcass feeding has the potential to evoke an awareness of animal welfare activities in zoos. It is quite possible that this interest could be a factor (appreciation, attribution, emotional inspiration, interaction and proximity) that builds visitors' connection to animals, as shown by Howell et al. (2019). Therefore, this study examined the educational effects of explaining the zoo animals' and laying hens' welfare to visitors using social media video streaming and feeding chicken carcasses in the exhibit.

Materials and methods

Carcass-feeding programme

Carcass feeding was conducted on two jaguars *Panthera onca* (F: born in 2013, M: born in 2014) kept at the Kyoto City Zoo . The two animals have been kept at the zoo since 2015. In total, the jaguars' normal feed consists of 0.5–1.5 kg of horse meat and 1–1.5 kg of chicken carcass (2.5 kg). The chicken carcasses are usually fed with the feathers removed and sometimes fed without being cut up.

The chicken carcasses used in this study (1.5–2 kg) were of laying hens used for welfare research at Azabu University. These laying hens were fed and drug-controlled for human consumption, the same way they are normally raised and marketed by farmers. After being slaughtered by inhalation of carbon dioxide gas, the carcasses were frozen at −20°C for about a week for parasite control. Then, they were thawed at room temperature for 72 hr before being fed to the jaguars. For this study, chicken carcass feeding was conducted by placing the whole carcass with feathers still attached on the ground in the jaguars' enclosure. This presentation aimed to extend the jaguars' foraging time and develop species-specific foraging behaviour in which jaguars move carcasses to a location where they can relax, take their time to disassemble the carcass and eat it.

Video exposure

The first phase of the study consisted of a video of the carcass-feeding event. The video showed the carcass feeding of two jaguars on a day when the zoo was closed in August 2021. This feeding scene was filmed and posted on YouTube (27 August 2021). The video included an introduction to animal welfare of laying hens (explaining animal welfare and how laying hens are raised) and an explanation of the purpose of carcass feeding. The video was posted on the zoo's official social media and in front of the jaguar enclosure so that it could be viewed by visitors to the zoo.

In-person exposure

The second phase was to exhibit carcass feeding to zoo visitors in person. The carcass feeding exhibition was held from 13

Table 1. Description of respondent groups

Periods	Group	Definitions
First 13 July 2021– 22 August 2021	Control A	Visitors who entered the zoo immediately after arriving
	Posted	Visitors who read the posting in front of the jaguar exhibit
Second 13 October 2021–3 November 2021	Control B	Visitors who entered the zoo immediately after arriving
	Non-viewing	Carcass feeding programme participants who had never watched the YouTube video streaming
	Viewing B	Carcass feeding programme participants who had watched the YouTube video streaming
Third 22 February 2022– 5 March 2022	Inexperienced	Visitors who had never seen the YouTube video streaming or participated in the carcass feeding programme
	Viewing C	Visitors who had only seen the YouTube video streaming
	Event Participation	Visitors who had participated in previous carcass feeding programme regardless of video viewing experience

October to 3 November 2021 (20 working days). Publicity for the carcass feeding was provided to zoo visitors through social media and postings in the zoo for five days before the exhibition. The carcass-feeding exhibit was held at 1000. One chicken carcass was fed to one jaguar per day with feeding on different days for the two jaguars. Jaguars fed on the carcass for as short as 1 hr and as long as 5 hr (including breaks). The jaguars were fed their normal diet on non-carcass-fed days. The purpose of the carcass feeding, the husbandry environment of the laying hens and egg prices were all explained to visitors before the feeding of the carcasses. Additionally, an educational sign regarding the animal welfare of laying hens and the price of eggs was posted in front of the jaguar exhibit facility between July 2021 and November 2021. These explanations and signs were accompanied by a message that encouraged visitors to direct the same interest they had in the jaguar husbandry environment to that of laying hens. The keeper's explanations and the jaguar exhibit's posted notices were simplified versions of the explanation in the video and did not include an explanation of 'animal welfare'.

Questionnaire content and distribution

Questionnaires were distributed to Kyoto City Zoo visitors and social media viewers. Three survey periods were set (Table 1): the first was designated as a control period from 13 July to 22 August 2021. During this period, no videos had been distributed and a notice about laying hens was posted in front of the jaguar exhibit. During this period (from 0900 to 1100), visitors who entered the zoo immediately after arriving were designated as control group A, whereas those who read the posting in front of the jaguar exhibit were designated as the posted group. Questionnaires were distributed to both groups. Of control group A, visitors who had already read the notice in front of the jaguar exhibit (self-reported) were excluded from the data.

The second period of the carcass-feeding event was from 13 October to 3 November 2021. During this period, visitors who entered the zoo immediately after arriving (from 0900 to 1100) were considered control group B and those who participated in the event were considered the carcass-feeding group. Questionnaires were distributed to both groups. During this period, visitors in control group B who had already read the notice were excluded from the study. To examine the effect of video distribution of the carcass feeding, the carcass-feeding group was divided into two groups, the non-viewing group and viewing group B, and these were compared with control group B in a three-group comparison.

The third period was conducted from 22 February to 14 March 2022 as a post-event survey of the carcass feeding. Two types of survey targets were set for this period: zoo visitors who participated in the carcass feeding of Amur tigers and lynx from 22 February to 5 March 2022 (the same foraging enrichment was conducted with a different animal species in order to bring back to the zoo visitors who participated in the jaguar carcass feeding exhibit) and viewers who responded to the survey posted on social media from 25 February to 14 March 2022. Data from these two types of subjects referred to as the post-hoc group were combined. Then, these subjects were compared by dividing them into three groups: an inexperienced group with no video viewing

Table 2. Questionnaire items and response options

Item	Response Options
Visitor age	Under 19 years, 20–39, 40–59, over 60
	"Do not wish to answer"
Visitor gender	Male, Female
	"Do not wish to answer"
Frequency of Kyoto City Zoo visits	Once every few years (<1 time/year)
	Once a year (1 time/year),
	Several times a year (>1 time/year),
	At least once a month (≥1 time/month),
Frequency of viewing Jaguar's Youtube channel and the carcass feeding video	I have seen that.
	I've never seen that.
Experience of Jaguar's Carcass-feeding video view	No experience
	Have experience
Importance of egg sales components	Freshness, nutrients, hen's HE, production area, price, producer, safety, type of hen
	Respondents select all of the above items on a 5-point scale.
	1: Not important 5: Important
Normal egg purchase price Desired purchase price of eggs from hens raised in a good environment	Enter the price of a 10-pack in figures
Degree of knowledge of animal welfare and environmental enrichment	I don't know
	I have heard of it, but cannot explain it
	I can explain.
Experience in viewing the notice in front of the Jaguar exhibit	No experience
	Have experience

experience or participation in jaguar events, a viewing group C with only video viewing experience and an event participation group that had participated in events regardless of video viewing experience. During the carcass feeding that occurred during the third distribution of the questionnaire, no explanation was given about animal welfare or the environment in which the laying hens were raised.

The survey items are listed in Table 2. The questionnaire items were selected with reference to Okabe and Matsunaga (2022) based on objective information about visitors to the zoo (gender, age, frequency of zoo visit, experience viewing official zoo jaguar videos on YouTube and experience viewing carcass feedings on the same channel). Questionnaire items related to egg purchase were based on egg characteristics listed by Ooki (2020), grouped into six categories (nutrients, hen husbandry environment, production area, producer, safety and type of hen). Currently, the sale of eggs with 'animal welfare' clearly indicated is limited in Japan, so it was not appropriate to make it an individual component in the questionnaire. Instead, the hens' husbandry environment was used as an indicator of animal welfare. Following Niiyama et al. (2007), 'price' and 'freshness' were also added to the questionnaire. The price of eggs normally purchased (ten eggs) and the desired spending price for eggs from laying hens raised in a good environment were added as items, the latter for questionnaires administered during the first and second periods only. A three-level selection (I don't know it, I have heard of it but can't explain it and I can explain it) was used to examine the impact of the level of knowledge about animal welfare and environmental enrichment on egg purchase price (note that knowledge of animal welfare and environmental enrichment here is not referring to specific animals, but considered in general).

This study was carried out in accordance with the recommendations in the "Guide for research ethics" of Kyoto City Zoo. The ethics committee of Kyoto City Zoo approved the study protocol (KCZ-2021-021).

Table 3. Percentage of respondents in Control A and B groups, posted group and carcass-feeding group (non-viewing and viewing B groups). $^{++}$ and $^{--}$: P<0.01, $^{+}$ and $^{-}$: P<0.05

	Sex		Age		Kyoto city zoo visit		Browsing the jaguar's channel		Knowledge of Animal welfare		Environmental enrichment	
Control A	Male	44.37	Under 19	8.61	<1 time/year	43.24	Not browsed	93.84	I can explain it	4.76	I can explain it	4.76
n = 151	Female	55.63	20 - 39	61.59	1 time/year	6.08	Have browsed	6.16	I have heard of it, but can't explain it.	12.24	I have heard of it, but can't explain it.	9.52
			40 - 59	23.84	≥1 time/year	43.92						
			Over 60	5.96	≥1 time/month	6.76			I don't know	82.99	I don't know	85.71
			Under 19	8.55	<1 time/year	46.58	Not browsed	92.47	I can explain it	2.70	I can explain it	2.70
			20 - 39	57.24	1 time/year	13.01	Have browsed	7.53	I have heard of it, but can't explain it.	16.89	I have heard of it, but can't explain it.	14.86
			40 - 59	30.26	≥1 time/year	33.56						
			Over 60	3.95	≥1 time/month	6.85			I don't know	80.41	I don't know	82.43
Control B	Male	43.60^{+}	Under 19	8.14	<1 time/year	46.39^{++}	Not browsed	96.51^{++}	I can explain it	2.33^{--}	I can explain it	3.49^{--}
n = 172	Female	56.40^{-}	20 - 39	56.40	1 time/year	13.25	Have browsed	3.49^{--}	I have heard of it, but can't explain it.	13.37^{--}	I have heard of it, but can't explain it.	9.88^{--}
			40 - 59	27.91	≥1 time/year	34.94						
			Over 60	7.56	≥1 time/month	5.42^{--}			I don't know	84.30^{++}	I don't know	86.63^{++}
Non-viewing	Male	33.33	Under 19	6.62	<1 time/year	38.35	Not browsed	91.11	I can explain it	13.13^{+}	I can explain it	16.42^{+}
n = 137	Female	66.67	20 - 39	53.68	1 time/year	12.78	Have browsed	8.89	I have heard of it, but can't explain it.	34.30^{++}	I have heard of it, but can't explain it.	24.63^{++}
			40 - 59	29.41	≥1 time/year	40.60						
			Over 60	10.29	≥1 time/month	8.27			I don't know	52.56^{--}	I don't know	58.96^{--}
Viewing B	Male	12.50^{--}	Under 19	8.70^{--}	<1 time/year	9.09^{--}	Not browsed	0.00^{--}	I can explain it	39.13^{++}	I can explain it	47.83^{++}
n = 24	Female	87.50^{++}	20 - 39	21.74	1 time/year	13.64	Have browsed	100.00^{++}	I have heard of it, but can't explain it.	47.83^{++}	I have heard of it, but can't explain it.	39.13^{++}
			40 - 59	47.83	≥1 time/year	40.91						
			Over 60	21.74	≥1 time/month	36.36^{++}			I don't know	13.04^{--}	I don't know	13.04^{--}

Statistical analysis

The respondent status bias in each period was compared using the χ^2 test and adjusted standardised residuals by Haberman's definition (Haberman 1973). Residual analysis is a method of analysing which category proportions are significantly different after a chi-square test. The Mann–Whitney U test (first period) or the steel method after the Kruskal-Wallis test (second and third periods) were used to compare the importance of the hens' husbandry environment and the purchase price of eggs (two types) between groups. The knowledge-level responses of the post-hoc group regarding animal welfare and environmental enrichment were scored for comparison as 0: I don't know, 1: I have heard of it but can't explain it and 2: I can explain it. This comparison of knowledge levels was also performed using the steel method after the Kruskal-Wallis test. Statcel4 (OMS Publishing, Saitama, Japan) served as a statistical processing software for this study. In addition, G*Power (Faul et al. 2007) was used for post-test power analysis. All data are presented as means with 95% confidence intervals.

Results

Video exposure

The number of views of the carcass-feeding video was around 1,004 (other videos introducing the environmental enrichment of jaguars had around 300 views).

Respondent bias

The composition of respondents is shown in Tables 3 and 4. The number of responses was 151 for control group A, 152 for the posted group, 172 for control group B, 161 for the carcass-feeding group (of which 24 had watched the carcass-feeding video—viewing B—and 137 had not—non-viewing group) and 112 for the post-hoc group (of which 81 were inexperienced, 13 video viewing—viewing C—and 18 event participation). The main respondents in the control A and B and posted groups were female, mostly in their twenties and thirties, who visited the zoo less than once a year or several times a year, had little interest in the zoo's information dissemination and had little knowledge of animal welfare or environmental enrichment. The non-viewing group had a larger proportion of female respondents than the control A and B and posted groups and more respondents were interested in animal welfare and environmental enrichment. Viewing group B had more female respondents than the non-viewing group, visited the zoo more frequently and were more interested in the dissemination of zoo information.

No significant bias was discovered for age, gender, frequency of visits to Kyoto City Zoo, experience viewing the jaguar YouTube channel or degree of knowledge of animal welfare and environmental enrichment in the control A and posted groups (age: χ^2=2.01, P=0.57, Cramer's V=0.08, 1−β=0.19, gender: χ^2=0.08, P=0.78, effect size: ϕ=0.02, 1−β=0.06, frequency of visits: χ^2=5.92, P=0.12, Cramer's V=0.14, 1−β=0.51, viewing experience: χ^2=0.04, P=0.64, effect size: ϕ=0.01, 1−β=0.06). There was no significant bias in the ratio of respondents' ages in control group B and the non-viewing and viewing B groups (χ^2=11.94, P=0.06, Cramer's V=0.13, 1−β=0.40). Among these three groups, there were significantly more males in control group B (χ^2=10.16, P<0.05, Cramer's V=0.18, 1−β=0.82) and significantly more females in viewing group B (P<0.01). Among these three groups significantly more people in control group B visited the zoo once every few years (χ^2=29.02, P<0.01, Cramer's V=0.21, 1−β=0.83) and significantly fewer people in control group B visited the zoo more than once a month (P<0.01). Conversely, in viewing group B, significantly more people visited the zoo once a month (P<0.01) and significantly fewer visited once every few years (P<0.01). A significantly higher proportion of control B group had no experience of viewing the jaguar YouTube channel (χ^2=180.04, P<0.01, Cramer's V=0.74, 1−β=1.00) and in viewing group B a significantly higher proportion had viewing experience (P<0.01).

The knowledge bias of animal welfare and environmental enrichment was significantly higher (animal welfare: χ^2=72.67, P<0.01, Cramer's V=0.33, 1−β=0.99, environmental enrichment: χ^2=74.46, P<0.01, Cramer's V=0.33, 1−β=0.99) in the 'I don't know it' group of control group B and significantly lower (P<0.01) in the 'I can explain it' and 'I have heard of it but can't explain it' groups.

Table 4. Percentage of respondents in inexperience, viewing C and event participant groups.

	Sex		Age		Kyoto city zoo visit		Browsing the jaguar's channel	
Inexperience n=81	Male	40.74	Under 19	6.17	<1 time/year	42.50	Not browsed	88.75
	Female	59.26	20 - 39	48.15	1 time/year	10.00	Have browsed	11.25
			40 - 59	40.74	≥1 time/year	35.00		
			Over 60	4.94	≥1 time/ month	12.50		
Viewing C n=13	Male	23.07	Under 19	0	<1 time/year	15.38	Not browsed	0
	Female	76.92	20 - 39	23.08	1 time/year	7.69	Have browsed	100
			40 - 59	61.54	≥1 time/year	38.46		
			Over 60	15.38	≥1 time/ month	38.46		
Event participant n=18	Male	27.78	Under 19	0	<1 time/year	5.55	Not browsed	5.56
	Female	72.22	20 - 39	16.67	1 time/year	5.55	Have browsed	94.44
			40 - 59	66.67	≥1 time/year	61.11		
			Over 60	16.67	≥1 time/ month	27.78		

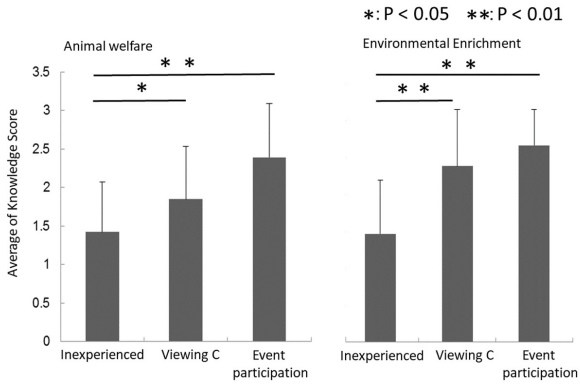

Figure 1. Comparison of knowledge scores on Animal welfare and environmental enrichment for inexperience, viewing C and event participant groups

There were significantly fewer respondents in the 'I don't know it' group of the non-viewing and viewing B groups (P<0.01) and significantly more respondents in the 'I can explain it' and 'I have heard of it but can't explain it' groups (non-viewing group 'I have heard of it but can't explain it': P<0.05; others: P<0.01).

The breakdown of respondents in the post-hoc group is shown in Table 4. Similar to the control A and B and posted groups, respondents in the inexperienced group were predominantly female, in their twenties–thirties, visited the zoo once every few years or several times a year, were not very interested in animal information dissemination and had no interest in animal welfare or environmental enrichment. On the other hand, the viewing C and event participation groups were dominated by females in their forties and fifties and many of them visited the zoo several times a year or more frequently. The χ^2 test could not be applied to the post-hoc group because of the low expected number of respondents. However, in the post-hoc analysis the inexperienced group was more likely than the other two groups to be male, under 40 years old and to not have watched the channel. Viewing group C was more likely to visit the zoo about once a year than the other two groups. The event participation group was more likely to visit the zoo several times or more than once a year than the other two groups. The results of the post-hoc questionnaire show that the event group had significantly higher knowledge of animal welfare and environmental enrichment (animal welfare: H=20.53, P<0.01, effect size:ε2=0.23, 1−β=0.55 ; environmental enrichment: H=31.11, P<0.01, effect size:ε2=0.34, 1−β=0.89) (Figure 1).

Comparison of items related to egg purchases for each group

Table 5 shows the ranking of each group in terms of the importance of the sales component of eggs. Freshness, safety, price and nutrients were the four most important factors in the purchase of eggs for almost all groups (type of hen was the fourth most important factor only for viewing group C). Thereafter, the rankings differed by group. Control group A ranked production area, type of hen, husbandry environment and producer fifth, sixth, seventh and eighth respectively. In the posted group, producer, husbandry environment, type of hen and producer were ranked fifth, sixth, seventh and eighth respectively. Control group B ranked production area, husbandry environment, type of hen and producer fifth, sixth, seventh and eighth respectively. The non-viewing group ranked production area, type of hen, producer and husbandry environment fifth, sixth, seventh and eighth respectively. Viewing group B ranked husbandry environment, producer, production area and type of hen fifth, sixth, seventh and eighth respectively. The inexperienced group ranked production area, type of hen, husbandry environment and producer fifth, sixth, seventh and eighth respectively. Viewing group C ranked nutrients, husbandry environment, producers and production area fifth, sixth, seventh and eighth respectively. The event experience group ranked husbandry environment, production

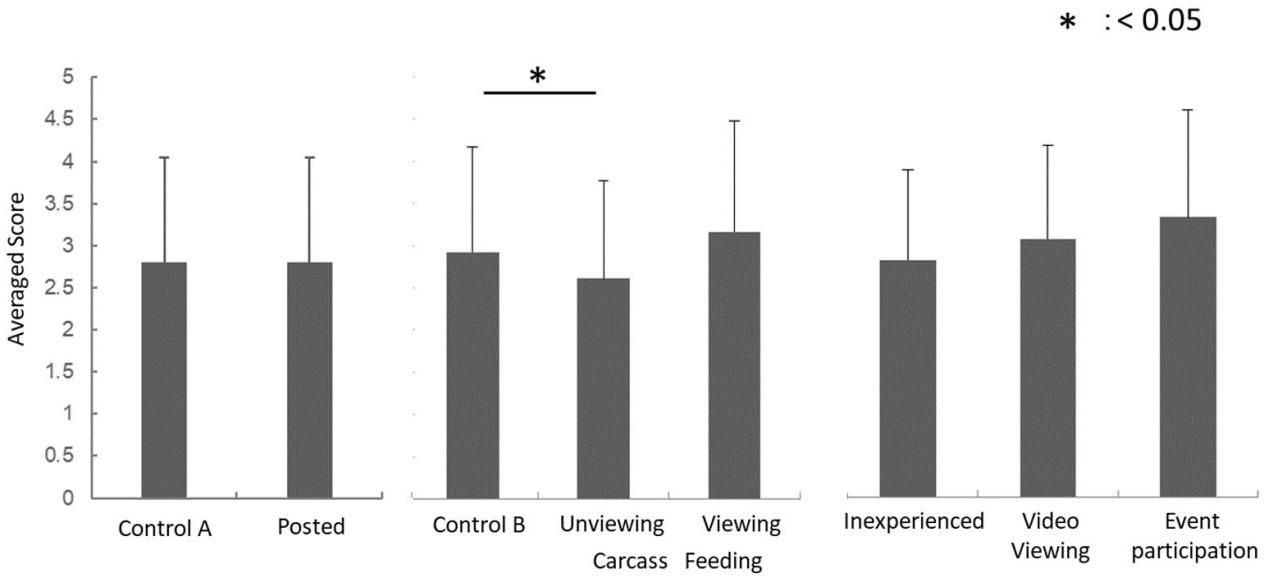

Figure 2. Comparison of the importance of 'hen's HE' for each group

area, producers and type of hen fifth, sixth, seventh and eighth respectively.

A comparison of the importance of the husbandry environment in each group is shown in Figure 2. There was no significant difference in the importance of the husbandry environment for the purchase of eggs (U=11296.5, P=0.95, effect size: r=0, 1−β=0.05) between the control A and posted groups. The husbandry environment was significantly less important for the purchase of eggs in the non-viewing group than in control group B (H=6.42, P<0.05, effect size:ε2=0.02, 1−β=0.06). There was no significant difference between the viewing B and control B groups (P=0.48).

Comparing the importance of the husbandry environment in the post-hoc group, there was no significant difference between the inexperienced group, viewing group C and the event participation group (H=2.95, P=0.22, effect size:ε2=0.03, 1−β=0.06).

Comparison of egg purchase price for each group

The purchase price of eggs for each group is shown in Figures 3 and 4. There were no significant differences in egg purchase price between control A and the posted group (U=10790, P=0.90, effect size: r=-0.5, 1−β=0.05) nor the desired price of eggs produced in a good environment (U=8842.5, P=0.12, effect size: r=-0.1, 1−β=0.11). Comparing control group B with the non-viewing and viewing B groups, there was no significant difference in egg purchase price (H=5.19, P=0.07, effect size:ε2=0.02, 1−β=0.06) and the desired purchase price of eggs produced in a good environment (H=1.77, P=0.41, effect size:ε2=0.01, 1−β=0.05). In the post-hoc questionnaire the event group had significantly higher egg purchase price than the inexperienced group (H=10.37, P<0.01, effect size:ε2=0.12, 1−β=0.15). However, viewing group C showed no significant difference in egg purchase price (P=0.31).

Discussion

While there was no significant bias in the status of respondents in the first phase, the two carcass-feeding groups were biased toward participants with high knowledge of animal welfare and environmental enrichment in the second phase, and the viewing B group was significantly biased toward those who had viewed the official zoo jaguar video on YouTube. Studies comparing zoo and non-zoo visitors have shown that the two groups have different perceptions of zoo animals and environmental enrichment (Reade and Waran 1996). The two carcass-feeding groups were considered to be potential animal- and zoo-interest groups. The percentage of respondents in the non-viewing group who answered “I don’t know it” for animal welfare and environmental enrichment was higher than that of viewing group B, which is thought to be due to the effect of watching the explanations in the video.

When purchasing eggs, the importance of the husbandry environment of laying hens was low in all groups. This is consistent with findings of lack of concern for livestock animal welfare in Japan (Kitano et al. 2022; Washio et al. 2019). The ranking of the hens’ husbandry environment did not change in the first and second periods and remained low for the control A/posted and control B/non-viewing groups. The non-viewing group scored significantly lower in the importance of husbandry environment than control group B. This contradicts studies on consumer animal welfare in Japan, where knowledge is considered a factor in product purchase (Kitano et al. 2022).

A study of zoo visitors’ perceptions of wildlife conservation showed a significant correlation with wildlife with which visitors felt connected (Howell et al. 2019). In other words, there is a bias in visitors’ perceptions of conservation on a per-animal basis. Translating this perspective to livestock welfare, the fact that the carcass-fed group was biased toward zoo/animal concerns in the second period suggests that this group of visitors may be more interested in jaguars and zoo animals and less interested in the animal welfare of hens. These differences in zoo visitors’ interest in animal species are similar to those found in conservation education research (Colléony et al. 2017).

When comparing the video viewing experiences of the carcass-feeding groups, video viewing group B attributed a medium level of importance to the husbandry environment of hens and there was no significant difference between this group and control group B. Like the non-viewing group, this group was biased toward respondents with higher levels of knowledge about animal welfare and environmental enrichment. In other words, it is possible that the zoo-interested group became more interested in the environment in which hens are kept as a result of watching the video. In studies of conservation education in zoos, changing attitudes is seen as a precursor to changing behaviour (Godinez and Fernandez 2019). Therefore, provision of information in advance through video distribution may have resulted in the development of predispositions in the animal welfare concern group.

Compared to the respective control groups, there were no significant differences in the first and second periods in the desired purchase price of eggs from conventional production systems and those from hens kept in a good environment. It is possible that carcass-feeding participation had not yet resulted in a shift in behaviour related to egg purchases. A comparison of the event participation group, viewing group C and the inexperienced

Table 5. Averagescore and order of importance of egg sales components (HE: husbandry environment). Results reported as mean±SD(rank).

Components	Nutrients	Hen's HE	Production area	Producer	Safety	Type of hen	Price	Freshness
Contral A	3.13±1.17(4)	2.80±1.25(7)	3.01±1.28(5)	2.75±1.06(8)	3.99±1.15(2)	2.89±1.09(6)	3.94±1.13(3)	4.23±1.14(1)
Post	3.26±1.24(4)	2.79±1.25(6)	2.91±1.29(5)	2.66±1.18(8)	3.94±1.13(3)	2.75±1.13(7)	3.96±1.15(2)	4.08±1.21(1)
Control B	3.37±1.18(4)	2.92±1.25(6)	3.05±1.21(5)	2.69±1.11(8)	4.04±1.01(2)	2.80±1.09(7)	3.89±1.16(3)	4.17±1.05(1)
Unviewing	3.19±1.15(4)	2.59±1.14(8)	2.76±1.19(5)	2.62±1.09(7)	3.71±1.20(3)	2.66±0.99(6)	3.97±1.06(2)	4.01±1.24(1)
Viewing B	3.25±0.94(4)	3.17±1.31(5)	2.92±1.38(7)	3.08±1.25(6)	3.63±1.21(2)	2.79±1.06(8)	3.58±1.21(3)	4.04±1.27(1)
Inexperienced	3.37±1.08(4)	2.83±1.06(7)	3.05±1.14(5)	2.70±1.07(8)	3.95±0.91(3)	2.88±0.98(6)	4.11±0.85(2)	4.24±1.05(1)
Viewing C	3.15±0.99(5)	3.08±1.12(6)	2.77±1.01(8)	3.00±0.91(7)	3.92±1.12(2)	3.23±1.01(4)	3.69±1.03(3)	4.46±0.78(1)
Event participant	3.33±0.84(4)	3.33±1.28(5)	2.94±1.00(6)	2.83±1.20(7)	3.89±1.02(2)	2.67±1.19(8)	3.56±1.15(3)	3.94±0.87(1)

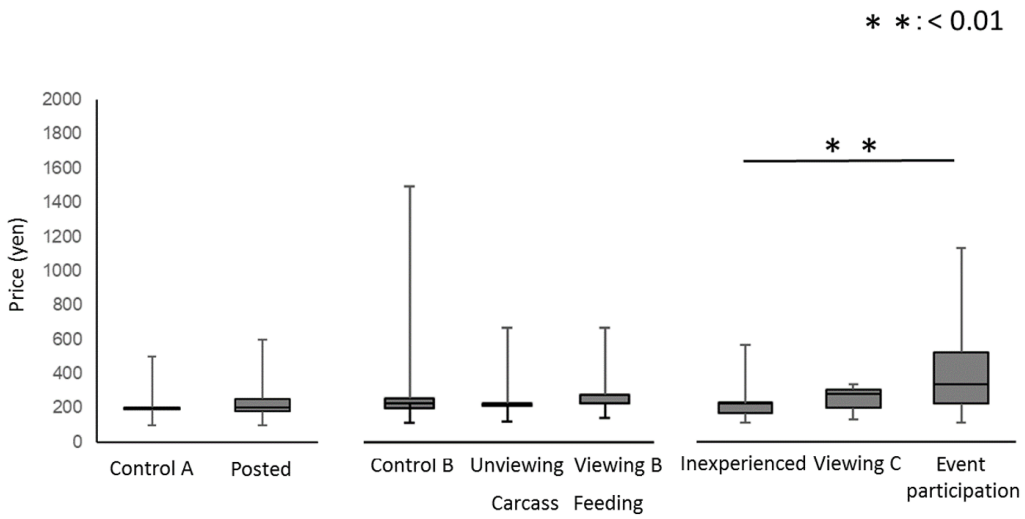

Figure 3. Comparison of usual egg purchase prices for each group

group in the post-hoc questionnaire revealed that the event participation group had significantly higher knowledge of animal welfare and environmental enrichment and a significantly higher purchase price of eggs than the inexperienced group. The level of importance of the hen's husbandry environment was similar to that of video viewing group B, positioned in the middle of the other items.

Studies on wildlife conservation education among zoo visitors have shown that knowledge enjoyment and direct interaction with animals (environmental enrichment practices) can lead to subsequent involvement in wildlife conservation behaviour (Collins et al. 2021). The current findings imply that the influence of knowledge enjoyment and direct experience may have led to an increase in the purchase price of eggs. On the other hand, the purchase price of eggs and the level of importance attributed to the husbandry environment for the video viewing group were not significantly different from those of the inexperienced group.

It is estimated that the price of eggs from hens raised using welfare-friendly methods will be higher than that from cage-raised hens (Kato et al. 2022). Therefore, the increase in purchase price of chicken eggs was considered to be the result of purchasing welfare-conscious eggs. In combination with the results of the event participation group, it is thought that the time interval between the direct experience of watching the video and the direct experience of viewing the exhibit, unlike the carcass-feeding group, did not result in a fundamental increase in egg purchase price.

Since the results are based on self-reporting, it is unclear whether actual behaviour change is occurring. The behaviour of visitors is not necessarily influenced by their knowledge (Moss et al. 2017). The Conservation Education Strategy (Thomas 2020) published by WAZA acknowledges that it is difficult to influence behaviour due to a visitor's own background. Investigating how to lower barriers to encourage visitors to take action (Routman et al. 2022) and create an environment where it is easier to practice action (e.g. in collaboration with souvenir shops: Swannie Sigsgaard 2009) may be necessary. Furthermore, regarding the post-evaluation of conservation education, WAZA's Conservation Strategy (Barongi et al. 2015) acknowledges that while responses have become easier to collect with the development of social media, there are still challenges in the evaluation process. For example, it may be useful to conduct evaluations based on comparisons with diverse data, such as number of searches (Fukano et al. 2020) or number of times a donation website is accessed (Fukano et al. 2021).

Unfortunately, power (1−β) of 0.15 was low for detecting the possibility of an increase in egg purchase price for the event group in the post-hoc questionnaire, which raises the question of whether the result is statistically meaningful. Similarly, the importance of the hens' husbandry environment in the non-viewing group, which was considered significantly lower when carcass feeding was conducted, also had low power. Therefore, in order to obtain reliable results, it is considered necessary to conduct continuous educational activities and to conduct a survey and questionnaire with a balanced sample size.

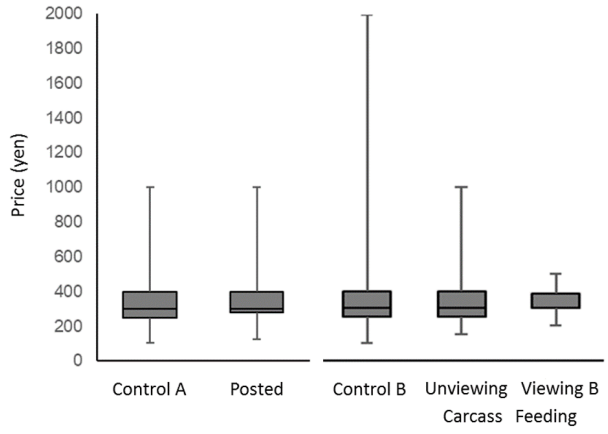

Figure 4. Comparison of the desired purchase price of eggs for hens raised in a good environment in each group

Collectively, these results indicate that both the knowledge gained from watching the video and the interest and understanding of animal welfare gained from carcass feeding may have resulted in an increase in the price of eggs purchased by zoo visitors. This change is considered to be similar to the results of studies on consumer behaviour in Japan (Kitano et al. 2022; Washio et al. 2019). A higher percentage of viewing group B and the event participation group increased their egg purchase price after viewing the zoo's official channel on YouTube. These groups may include a large number of people who are interested in zoos. Therefore, it is conceivable that the study may have at least broadened the interest of visitor groups interested in the zoo. The results of this study indicate that awareness-raising through carcass feeding may be effective for these interested groups, but that further study is required for the indifferent groups that do not frequently visit zoos.

Conclusion

Taken together, these results suggest that educating people about hen welfare through carcass feeding of jaguars with laying hens in the zoo increases the price for which participants purchase eggs and increases their perceived level of importance of the hens' husbandry environment. Provision of knowledge on hen care and management and the experience of gaining empathy for the animals were considered effective in making this change. However, it is possible that respondents were highly biased toward those already concerned about zoos. Therefore, it is considered necessary to conduct continuous educational activities to promote awareness of animal welfare among visitors who are not particularly interested in zoos.

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