Does supplementary feeding affect organ and gut size of wild red-legged partridges Alectoris rufa?

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Source: Wildlife Biology, 9(3) : 229-233

Published By: Nordic Board for Wildlife Research

URL: https://doi.org/10.2981/wlb.2003.055

SHORT COMMUNICATION

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Does supplementary feeding affect organ and gut size of wild red-legged partridges *Alectoris rufa*?

Javier Millán, Christian Gortazar & Rafael Villafuerte

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Supplementary feeding of wild red-legged partridges *Alectoris rufa* with wheat is a widespread management practice in hunting areas in Spain. Many studies note that energetic diets affect the physiology of hand-reared galliforms. In order to assess if cereal supply might also affect wild birds, we studied the weight of the heart, spleen and liver, and the length of the small intestine and caecum of 129 wild red-legged partridges from three hunting estates where wheat is supplied, and compared it with 67 partridges from two non-supplied estates. Non-supplied partridges had heavier hearts (9%, both in juveniles and adults), and longer caeca (20% in juveniles and 14% in adults) than supplemented birds. An excessive intake of energy-rich items, such as the wheat supplied, instead of fibre-rich or proteic natural food, might explain the differences found. The management implications of these findings are discussed.

Key words: Alectoris rufa, artificial feeding, gamebird, management, physiology, red-legged partridge, splanchnometry

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Received 12 August 2002, accepted 22 January 2003

Associate Editor: Simon Thirgood

Supplementary feeding of wild red-legged partridges *Alectoris rufa* is currently a widespread management tool in Spanish hunting areas, and about 10% of the estates in southern Spain employ the practice (J. Millán, pers. obs.). Wheat is supplied in feeders or even spread along the tracks on many estates. No data on the consequences of this management tool are available in Spain. Supplementary feeding of gamebirds could be useful during severe winters (Townsend, Lochmiller, De Maso, Leslie, Peoples, Cox & Parry 1999) or when carried out to improve the success of gamebird releases (Draycott, Hoodless, Ludiman & Robertson 1998). However, no apparent benefits on gamebird production have been found in other studies (e.g. Hoodless, Draycott, Ludiman & Robertson 1999, Marjakangas & Puhto 1999), and even detrimental effects, such as aflatoxin production in bird feeders (Oberheu & Dabbert 2001), or increased predation rates (Huhta, Siekkinen & Keränen 1994), have been observed.

As in other galliforms (Moss 1972, Putaala & Hissa 1995), farm-reared red-legged partridges show physiological differences when compared with their wild counterparts (Millán, Gortazar & Villafuerte 2001). Although other factors may also be involved, the composition of the diet that captive birds receive plays a major role in these findings (e.g. Moss 1972, Liukkonen-Anttila, Kentala & Hissa 2001). In fact, juvenile captive red-legged partridges born in June and fed a fibre-rich diet from July to December showed heavier gizzards and longer intestines than those fed commercial feed (Millán, Gortazar, Buenestado, Rodríguez, Tortosa & Villafuerte 2003). However, there are fewer data on the effect of the cereal supply on the physiology of wild galliforms (Peoples, Lochmiller, Boren, Leslie & Engle 1994). Marjakangas (1984, 1985) noted that black grouse *Tetrao tetrix* fed oats contained significantly less minerals in their tissues than control birds and had shorter caeca.

In some hunting estates in southern Spain, with intense year-round food supplementation and high partridge densities, summer increases in partridge mortalities have been repeatedly noticed (D. Fernández de Luco, pers. comm.; C. Gortazar, pers. obs.). The reasons for these deaths could be similar to the sudden deaths observed in broiler chickens. In this syndrome, among other causal factors, the feeding of energy-rich diets leads to an unbalanced development of the myocardium (Báez 1994). Thus, the energetic diet fed to these partridges might be one of the factors involved in high levels of mortality. In order to assess if the supplementary feeding affects partridge splanchnometry, and therefore could be a predisposing factor for summer mortalities, for increased predation risk, or for other non-hunting losses, we measured the size of gut and internal organs of partridges from hunting areas where wheat is supplied, and compared it with partridges from non-supplemented estates.

Material and methods

We collected 196 shot wild red-legged partridges from five Spanish hunting areas in October 1999, 2000 and 2001. Of these partridges, 129 came from three estates where wheat is supplied (hereafter 'supplied': 04°29'W 38°43'N, collected in 2000; 03°05'W 39°00'N, collected in 1999; and 05°58'W 36°27'N, collected in 1999), and 67 to two non-supplemented estates (here-

Table 1. Mean ± SD fresh weights (in g) of the heart, spleen and liver and lengths (in cm) of the small intestine and the caecum of wild red-legged partridges in relation to estate of origin (wheat-supplied vs non-supplied), age and sex. The number of organs examined is given in parentheses. Superscripts indicate the statistical significance of the effect of the characteristics of the origin ([a] $P < 0.001$), effect of the sex ([b] $P < 0.001$), and effect of the age ([c] $P < 0.01$, [d] $P < 0.05$). We used three-way ANCOVA in all cases, with the partridge head and body length as the covariate.

	Wheat-supplied				Non-supplied			
	Adults		Juveniles		Adults		Juveniles	
	♂	♀	♂	♀	♂	♀	♂	♀
Heart (g) [a, b]	1.82 ± 0.30 (34)	1.43 ± 0.19 (24)	1.80 ± 0.17 (25)	1.42 ± 0.24 (40)	2.04 ± 0.25 (13)	1.50 ± 0.27 (9)	1.93 ± 0.16 (13)	1.57 ± 0.19 (23)
Spleen (g) [d]	1.53 ± 1.56 (32)	1.99 ± 1.99 (20)	0.94 ± 1.61 (20)	1.28 ± 1.80 (32)	2.27 ± 3.42 (12)	1.06 ± 1.23 (8)	0.77 ± 1.21 (14)	1.34 ± 1.85 (22)
Liver (g)	8.18 ± 1.19 (34)	7.89 ± 1.34 (24)	8.30 ± 1.56 (25)	7.56 ± 1.96 (40)	8.31 ± 1.57 (12)	7.86 ± 2.26 (7)	7.57 ± 1.16 (15)	7.28 ± 2.06 (24)
Small intestine (cm) [c]	70.23 ± 8.61 (33)	71.28 ± 8.74 (24)	73.68 ± 10.34 (25)	73.35 ± 10.08 (40)	69.63 ± 4.56 (13)	70.35 ± 6.33 (9)	75.24 ± 10.13 (15)	75.42 ± 10.74 (25)
Caecum (cm) [a]	14.99 ± 3.28 (33)	14.46 ± 3.68 (24)	14.17 ± 2.36 (25)	14.32 ± 2.49 (40)	16.74 ± 1.56 (13)	16.84 ± 2.33 (9)	17.72 ± 2.21 (15)	16.41 ± 2.03 (24)

after 'natural': 00°91'W 41°25'N, collected in 1999 and 2001; and 04°29'W 39°90'N, collected in 1999). All five sampling areas are agroecosystems dominated by cereal crops (wheat and barley) with sparse patches of natural vegetation. Therefore, we do not believe that the geographical origin of the samples had a significant effect on the observed differences. Partridges were sexed by gonadal observation, aged by the characteristics of their wingtips (Sáenz de Buruaga, Lucio & Purroy 2001) and measured from the tip of the beak to the base of the tail. The heart, spleen and liver were weighed to the nearest mg and the small intestine and caecum were measured to the nearest mm following Millán et al. (2001). We also identified and quantified the helminth fauna and carried out a coprological analysis in all the partridges. These results will be published elsewhere.

Adjustment by covariance analysis reduced variation due to total length (Brown, Southern & Baker 1985). Thus, we used three-way ANCOVAs to compare the organ size depending on the partridge origin (supplied vs natural), sex and age in all cases, using partridge head and body length as covariates. The dependent variables were normalised when needed.

Results

Partridges from natural areas had heavier hearts (9%, both in juveniles and adults, $F_{1, 171} = 13.1$, $P < 0.001$) and longer caeca (20% in juveniles and 14% in adults, $F_{1, 173} = 28.0$, $P < 0.001$) than partridges from supplied areas (Table 1).

Independently of the origin of the samples, we found some effect of age and sex on organ size. Adult partridges had heavier spleens ($F_{1, 159} = 4.0$, $P < 0.05$) but shorter small intestines ($F_{1, 174} = 7.4$, $P < 0.01$) than juveniles, and males from both age groups had heavier hearts ($F_{1, 171} = 86.6$, $P < 0.001$) than females.

On the supplied estates, partridges harboured low numbers of *Trichostrongylus tenuis* (range: 0-20), whereas partridges from the other areas did not have caecal parasites. Numbers of coccidia propagules were moderate (range: 0-1,000 oocysts/g faeces) in both groups.

Discussion

Access to more abundant, palatable, digestible, water-rich and energetic food such as cereal seeds might result in galliforms feeding mostly on them instead of natural items, as observed by Marjakangas (1984). In fact, Moss (1972) observed a change in both voluntary intake and composition of the diet used by red grouse *Lagopus lagopus scoticus* in captivity. Feeding more on wheat and less on other natural food items may eventually reduce the quantity and quality of, among other components, protein and fibre in the diet.

Heart weight

Intensive production of broiler chickens has repeatedly been associated with cardiac troubles such as ascytes (e.g. Wilson, Julian & Barker 1988) and sudden deaths (Greenless, Eyre, Lee & Larsen 1989). Broilers with ascytic syndrome have smaller hearts than broilers without ascytes (Currie 1999, Olkowski, Korver, Rathgeber & Classen 1999). Thus, we suggest that diets with more energy and less protein, such as those of partridges from managed areas, may cause the observed differences in the relative size of the heart. Partridges with smaller hearts may have a lowered ability to avoid predation because their chance of performing an explosive exercise may be lower, and they may even be of lower value for hunters, since their ability to perform large and fast flights may be poorer (Putaala & Hissa 1995). In addition, they may be more susceptible to stress- or heat-caused sudden deaths. Thus, the wheat supplementation could eventually be involved in the summer mortalities observed in Spanish red-legged partridges.

Gut length

In agreement with Marjakangas (1985) findings in black grouse, we found the caeca of supplied partridges to be significantly shorter than those of control birds. In our study, the mean length of the caecum of partridges from wheat-supplied areas is closer to that reported for farmed partridges than to that of wild partridges, as described in Millán et al. (2001). Although many factors are known to affect gut size (Moss 1972), fibre content of the diet seems to play a major role (Leopold 1953). Fibre-rich diets increase the energy uptake in galliforms (McBee & West 1969), and rock partridges *Alectoris graeca* with larger intestines survived longer after release (Paganin, Dondini, Vergari & Dessi-Fulgheri 1993, but see Millán et al. 2003). Food supplemented partridges were also found to have higher burdens of caecal parasites than partridges from natural areas. However, in the red-legged partridge, no relationship between *T. tenuis* burden and caecum length has been established (J. Millán, pers. obs.). Thus, we believe that supplementary feeding is the most likely cause of the observed differences. In contrast, small intestine length was apparently not affected by the supplementary feeding. The functions of the small intestine are known to include the digestion of sugars (Moss 1972), whereas the caecum of galliforms is important for microbial fermentation, including some transformation of cellulose (Mead 1989), and especially for the absorption of water and non-proteic nitrogen (Remington 1989). That the differences only appeared in caecum length may be explained by the fact that cereal seed is composed mostly of sugars. We found the small intestine to be longer in young partridges than in adults, which is in accordance with Pulliainen (1976), who found that the relative intestine length was longer in young willow grouse *Lagopus lagopus* than in adults. He concluded that this was because the absorptive function of the gut lining was not fully developed in young birds.

Spleen and liver weight

We found no differences in spleen and liver weight in relation to partridge origin. This was unexpected, as both organs showed marked differences between wild and farmed red-legged partridges (Millán et al. 2001), and the spleen was also lighter in farmed partridges fed with a fibre-rich diet (Millán et al. 2003). These contrasting results suggest that the effect of captivity on spleen and liver size may be caused by a deficiency in other unidentified diet components that partridges are able to find in the wild. However, spleen weight was higher in adult partridges. This could have been due to longer exposure to pathogens or a higher immune ability of this age group. However, the cause of death, with haemorrhages and bleeding, probably influences the size of the spleen, making it difficult to draw conclusions.

Management implications

Partridges from wheat-supplemented hunting estates with smaller hearts may be poor fliers and thus may be more susceptible to predation, and may even be more predisposed to suffer from circulatory troubles. Because of the reductions in their gut size, they may also become more and more dependent on supplementary feeding. Therefore, we suggest that supplementary feeding should only be offered in some seasons such as winter or in special circumstances such as restocking operations or prior to female egg-laying. Supplementary feeding should not be offered when the chicks are still growing, in order to avoid an unbalanced physiological development. However, long-term studies on the effect of this and other management tools on red-legged partridge are needed in order to investigate their possible adverse effects on populations over generations.

Acknowledgements - this is a contribution to CICYT PB1-02-004, to FEDER-UE 1FD1997-2299 and to a joint project CSIC/Principado de Asturias. We wish to thank Adela García (Aragón Government), Alfredo Peña, David Huertas, José A. Ortiz, Gregorio Mentaberre, Isabel García, Carla Johnson, Javier 'D'Artagnan' Viñuela and two anonymous reviewers for their assistance.

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