



Effect of limestone particle size on performance, eggshell quality, bone strength, and in vitro/in vivo solubility in laying hens: a meta-analysis approach

F. Hervo ^{*,†,1} A. Narcy [†] Y. Nys[†] and M.-P. Létourneau-Montminy^{*}

^{*}*Département des sciences animales, Université Laval, Québec city, Québec, G1V 0A6, Canada; and* [†]*INRAE, Université de Tours, BOA, 37380, Nouzilly, France*

ABSTRACT Numerous publications over the past 5 decades have investigated the effect of limestone particle size (**LmPS**) on production performance, bone mineralization, and limestone solubilization in laying hens. Coarse limestone particles have been shown to improve eggshell quality and bone mineralization. However, there is a large variability of responses in birds to this factor, indicating the need to better quantify the effect of modulating factors related to coarse particles that could explain this variability. The objective of this meta-analysis was to study the impact of LmPS on the digestive and metabolic fate of Ca to optimize its utilization by laying hens. Fifty-eight papers published between 1971 and 2019, including 71 experiments were included in this study. Four categories of dependent variables were identified: Ca solubility, production performance, eggshell quality, and bone strength. Independent variables tested were LmPS and age. Results showed that the in vitro solubilization of limestone linearly decreased ($P < 0.001$;

$R^2 = 0.91$) while in vivo solubilization linearly increased with LmPS ($P < 0.001$; $R^2 = 0.91$). Coarse limestone particles were retained longer in the gizzard ($P < 0.001$; $R^2 = 0.60$), inducing higher solubilization by gastric juices than fine limestone. LmPS showed no effect on production performance while all eggshell quality parameters increased with LmPS ($P < 0.001$; $R^2 > 0.91$): increasing specific gravity by 0.8%, eggshell thickness by 1.1%, and eggshell breaking strength by 3% when increasing from 0.15 mm to 1.5 mm. LmPS had an effect on tibia breaking strength dependently of age (Age \times LmPS, $P < 0.001$; $R^2 = 0.89$): coarse limestone particles increased tibia breaking strength with aging compared to fine limestone particles. The current study renders it possible to quantify the effects of age and LmPS on eggshell quality and tibia breaking strength. This work showed an interaction between eggshell quality and bone strength and showed that LmPS increases bone strength in older laying hens.

Key words: laying hen, limestone particle size, eggshell quality, bone strength, limestone solubilization

2022 Poultry Science 101:101686
<https://doi.org/10.1016/j.psj.2021.101686>