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Calcium carbonate pellets from drinking water decarbonisation as a substitute for lead in shotgun cartridges

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Abstract

Lead as a material for shot in cartridges for hunting or shooting shotguns has many disadvantages for human and animal health as well as for environmental quality. Metal substitutes can compensate these disadvantages only partly. This paper tested calcium carbonate pellets (ECO-shot) from drinking water decarbonisation as a substitute for metal shot. Although totally environmental friendly, ECO-shot have shooting characteristics which are very different from metal shots. However, for the sake of health and the environment, changes to the whole shooting system (cartridge, gun etc.) may be worthy of consideration.

Key words: lead shot, hunting, Pb

Zusammenfassung

Kalkperlen aus der Trinkwasser-Entcarbonisierung als Ersatz für Blei in Schrotpatronen

Bleischrote in Jagd- und Sportmunition haben zahlreiche Nachteile für die Gesundheit von Mensch und Tier und stellen eine erhebliche Umweltbelastung dar. Der Austausch gegen andere Metalle und Legierungen kann diese Nachteile nur teilweise beheben.

Die Arbeit stellt Calciumcarbonat Pellets (ÖKO-Schrot) aus der Trinkwasserenthärtung als neuartiges Ersatzmaterial für Metallschrote. ÖKO-Schrot ist zwar absolut umweltfreundlich, seine Schusseigenschaften sind von Metallschroten stark verschieden. Im Hinblick auf den Schutz von Gesundheit und Umwelt erscheint es daher lohnend in Überlegungen zur Optimierung der Schussergebnisse von Ökoschrot auch Modifikationen an Patronen und Waffen einzubeziehen.

Schlüsselworte: Bleimunition, Jagd, Pb

1 Introduction

Lead (Pb) is still the most frequently used material for pellets in hunting and sport shooting cartridges. Alternative metals for pellets, such as iron (Fe), molybdenum (Mo), nickel (Ni), bismuth (Bi), zinc (Zn) and tin (Sn) are still not common. Annually about 1.500 t of Pb is released to the environment during hunting and on shooting ranges in Germany (6). With the exception of Fe, all other materials may contribute to the heavy metal pollution of soils and groundwater, but Pb is the most critical element due to its predominant use and high toxicity (Windholz et al., 1976). Pb shot either contaminate soils, animals or humans by direct hits, or indirectly when Pb enters the food chain by the intake of fish, birds and game. The cost for the decontamination of German shooting ranges is estimated to amount up to 7.5 billion ECU (4). Pb is highly toxic and even minute amounts may cause severe health damage to humans in the form of physiological and neurological diseases and poisoning of animals, particularly waterfowl (6). The digestion of only a single Pb pellet may be lethal for duck (4). The growing awareness of this problem resulted in a general ban of lead shot in Denmark and The Netherlands from 1993 (4). Pb shot can be favourably replaced by steel shot on the basis of environmental protection, ballistic criteria and price (Anon, 2000 1994 a). This contribution proposes a new approach to the substitution of Pb shot by using calcium carbonate pellets derived as residual products from drinking water decarbonisation (Stetter & Overath, 1996). These pellets are currently used in the cement and building industry, but still excess material has to be disposed of (Stetter & Overath, 1996). The use of these pellets for shot would contribute to safe and environmentally friendly hunting and shooting and would be in line with the new German "Waste Avoidance, Recovery and Disposal Act" which focuses on waste management with a closed substance cycle in order to conserve natural resources and to ensure an environmentally acceptable disposal of waste (Anon, 1994a).

The possibility of using calcium carbonate pellets for shot has been demonstrated in shooting experiments.

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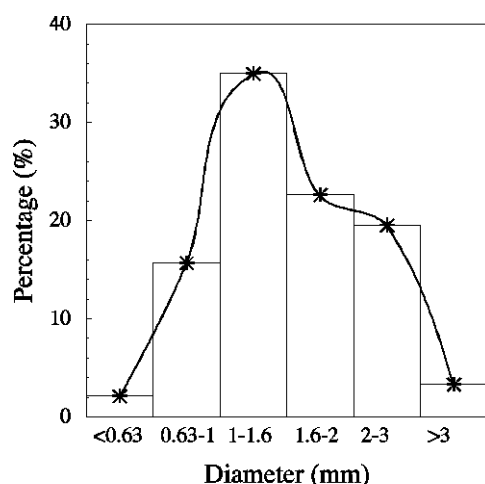


Fig. 1: Particle size distribution of calcium carbonate pellets from a water decarbonisation plant (lot originates from the water works at Meerbusch, Germany)

2 Pellets from drinking water decarbonisation

Decarbonisation of drinking water is carried out in water treatment plants to enhance the quality of drinking water. Ground water and calcium carbonate slurry enter the bottom of a cylindrical reactor of about 3 meters wide and 7 meters high and are streamed upwards with a speed of up to 100 m h^{-1} . During the ascent of the mixture, crystallisation of calcium carbonate is initiated by adding small quartz (sand) or lime stone particles on which white spherical calcium carbonate pellets between 0.5-4.0 mm grow. The particle size distribution of the sample used in this experimental work is given in figure 1. Depending on the techniques employed, other plants may produce different particle size distributions. The process yields 300 to 500 g calcium carbonate pellets per m^3 water (Stetter & Overath, 1996). The material of the pellets has a specific gravity of 2.7 g cc^{-1} and a hardness of 3 (according to Moh).

Table 1: Characteristics of different types of ammunition

Type of shot	Melting point ($^{\circ}\text{C}$)	Density (g/cc)	Size (mm)	Price (ECU) ¹
Bi	271.3	9.5	2.5 - 4.0	0.74
Pb	327.5	11.3	2.5 - 4.0	0.47
Steel ²	1535.0	7.8	2.8 - 3.25	0.45
ECO	1339.0	2.7	2.5 - 4.0	0.01

¹ caliber 12; ² standard steel

3 Preparation of ECO-shot

From a lot of calcium carbonate pellets which originated from the waterworks in Meerbusch, Germany, pellets with a diameter of 3 mm were retained by sieving. The lead shot (34.3 g GECO-X-Hardshots) were removed from standard shotgun cartridges (Dynamit Nobel "Rottweil Jagd" 12/70, No. 5, 3mm, game load) and replaced with 6 ml of 3 mm calcium carbonate pellets (9.04 g) (figure 2). All other characteristics of the cartridges were unchanged. The shot were not placed in a sachet or arranged inside the cartridge shot chamber. The cartridges filled with calcium carbonate pellets are further referred to as "ECO" pellets and shot. A comparison of some characteristics of different types of ammunition used in shotguns is given in table 1.

The density of a calcium carbonate pellet is about one third to one quarter that of steel and Pb, respectively. This has implications for the suitability of this material for shot and is discussed later. However the costs for the ECO product are negligible.

4 Shooting test with ECO-shot

The result of shooting on a cardboard target (\varnothing of outer circle = 70 cm) with traditional 3 mm Pb shot and ECO shot using a 12 bore shotgun (Anton Zoli Arms, Bardore, Italy) from a distance of 10 meters is given in figure 3.

The results of the shooting experiment reveal that the coverage of the ECO-shot is much broader, which is a result of the lower specific weight of the pellets (table 1).



Fig. 2: ECO and Pb shot (left); Replacing Pb shot with ECO shot (right)

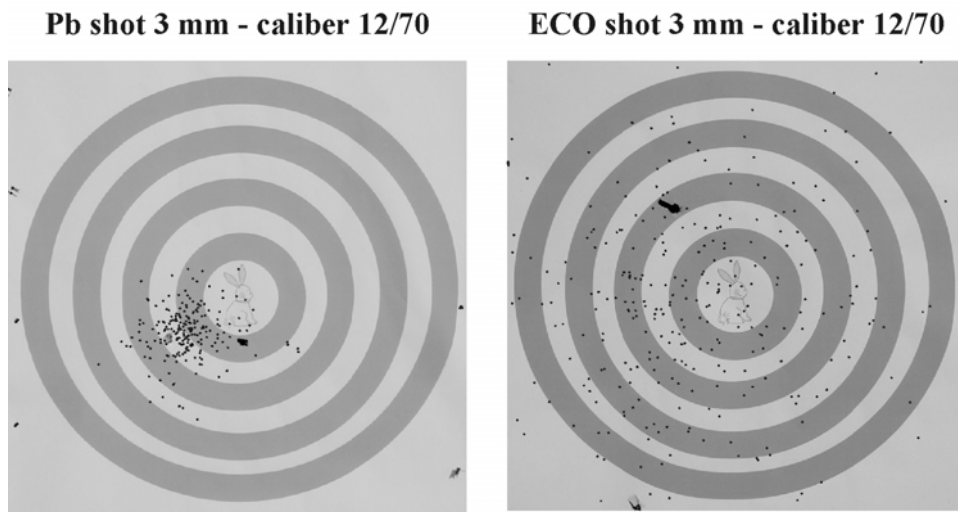


Fig. 3:
Comparison of shooting results yielded with Pb and ECO shot (pellets 3 mm; 34.3 g Pb, 9.04 g ECO-shot; calibre 12/70; target \varnothing 70 cm, distance 10 meters)

Considering that the ECO-shot were not placed in a sachet and not positioned within the cartridges shot chamber, the distribution over the target area is satisfying (figure 3).

The ECO-shot did not disintegrate on impact as can be seen in figure 4 in which the penetration of the shot into the pinewood mount of the cardboard target is shown. This implies an overall favourable transfer of the kinetic energy of the shot into the target.

5 Discussion

The increasing ecological awareness of the hazardous impact of lead shot already led to a general ban on lead products in Denmark and The Netherlands (4). In other countries, Pb shot are forbidden in the hunting of waterfowl which are particularly sensitive to Pb poisoning (11; 7). The preferred substitute to Pb shot is steel shot which is environmentally friendly, but objections against this ammunition include inferiority at longer ranges, choke expansion, more residues and ricochets (11; 10; Kinsky, 1994). Consequently alternatives are still required.

The great advantage of calcium carbonate pellets over all other materials used for hunting or shooting are their absolute environmentally friendliness. From the perspective of soil acidification they even provide beneficial effects (the distribution of fertilisers by explosives has already been described by Snait (1979)). Calcium carbonate pellets clearly have different shooting behaviour characteristics compared with pellets made from any metal. One may have to consider changing other parameters such as cartridge size and design as well as the design of the shotgun itself to obtain optimised shooting results with a different but environmentally uncompromising material, but such charges may be justifiable.

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Fig. 4:
Penetration of ECO-shot into the pinewood mount of the target

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