Journal of Consumer Protection and Food Safety (2022) 17:279–284
https://doi.org/10.1007/s00003-022-01384-y

Journal of Consumer Protection and Food Safety
Journal für Verbraucherschutz und Lebensmittelsicherheit

ANNOUNCEMENTS & REPORTS

Report on the technical discussion "Methods of detection of bullet fragments and measurement methods for the description of a reliable killing effect in simulants"

Monika Lahrssen-Wiederholt[1] · Helmut Schafft[1] · Gernot Pieper[2] · Ingo Rottenberger[1] · Johann Höcherl[3] · Christian Schyma[4] · Michael Marahrens[5] · André Schröder[6] · Ellen Ulbig[1]

Published online: 29 July 2022

Abstract

In the context of the discussion on an amendment of the Federal Hunting Act, the Federal Institute for Risk Assessment (BfR) in Germany has dealt with scientific principles that enable an assessment of the introduction of bullet fragments into game meat. Until now, neither standardized terms nor definitions nor standardized procedures for quantifying the effects of the introduction of corpuscular bullet fragments were available for a health assessment. With the participation of international experts, a concept was developed that could be used to test hunting rifle bullets regarding their effectiveness potential [The term effectiveness potential (in German: Wirkpotenzial) describes more than the term "effectiveness" (in German: Wirksamkeit)] and entry of bullet fragments into game or game meat. The term "killing effect" newly introduced into the discussion in the context of the efforts to amend the Federal Hunting Act was not supported by the experts, since "killing" cannot be simulated and standardized. Other basic terms and definitions were formulated and/or interpreted. A distinction must be made between the effect of a bullet on biological tissue, the (optimal) effect of the bullet when shot in a manner appropriate for hunting, the impact on the hunted game when hit in a suitable location and the effect of the bullet, described as physical effectiveness potential. In principle, the following applies: The effectiveness potential of a bullet can be simulated and thus evaluated in test simulants/test media. Therefore, it is possible to describe hunting rifle bullets based on qualitative and quantitative parameters as well as concerning their physicochemical properties. Their effectiveness potential in game meat can thus be adequately assessed, both by the hunter and with a view to the scientific issues related to consumer health protection strategies for minimizing bullet fragments in game meat. Essential parameters required for a test procedure have been compiled in a product profile for hunting rifle bullets used to kill food-producing game species.

André Schröder: Participation as an independent expert of the professional association.

✉ Ellen Ulbig
Ellen.Ulbig@bfr.bund.de

[1] Bundesinstitut für Risikobewertung, Max-Dohrn-Str. 8-10, 10589 Berlin, Germany

[2] Bundespolizeipräsidium, Forschung und Erprobung, Ratzeburger Landstraße 4, 23562 Lübeck, Germany

[3] Universität der Bundeswehr in München, Waffen- und Munitionstechnik, Werner-Heisenberg-Weg 39, 85577 Neubiberg, Germany

[4] Institut für Rechtsmedizin, Abteilung Forensische Medizin und Bildgebung (F&E), Universität Bern, Murtenstrasse 26, 3008 Bern, Switzerland

[5] Friedrich-Löffler-Institut, Institut für Tierschutz und Tierhaltung, Dörnbergstraße 25/27, 29223 Celle, Germany

[6] Fachverband Groß- und Außenhandel mit Jagd- und Sportwaffen e.V. im Bundesverband des Deutschen Groß- und Außenhandels e.V., Am Weidendamm 1 A, 10117 Berlin, Germany

Keywords Game meat · Minimization of bullet fragments · Standard methods · Impact of bullets · Physical effectiveness potential of bullets · Product profile for hunting rifle bullets

1 Background

The intentional, deliberate use or entry of substances into feed or food along the food chain takes place with different purposes. Some examples are the use of plant protection products, veterinary drugs, or food or feed additives. In order to enable the application or use of substances, a large number of these substances undergo authorization procedures. One of the main objectives of these procedures is to ensure the safety of the substances for the user, the consumer, and the animal by means of prescribed, standardized test procedures and to verify the efficacy of the use or discharge. Standardized analytical methods usually allow the detection of the substances or their residues in or on the food. European or worldwide approved test or analysis procedures ensure the reproducibility and scientific acceptance of the test results.

In hunting practice with hunting rifle bullets, animals are killed by a deliberate entry of bullets. In this context, practical hunting practice always aims to kill wild animals by surprise through a well-aimed shot while avoiding pain (Schaller 2020). Depending on the ammunition used in hunting and the respective impact, deformation, and disintegration behavior of the bullets, residues of varying amounts may remain in the game meat. Thus, in addition to the question of effectiveness—a reliable kill—there is also the question of the safety of the foodstuff "game meat" as a result of consumption.

In the course of discussions on an amendment to the Federal Hunting Act, the BfR is involved in the development of procedures to demonstrate the minimization of lead input from hunting rifle bullets into the foodstuff "game meat". According to a draft of the amendment to the Federal Hunting Act, the following changes, among others, are to be introduced or the following objective is to be considered (Bundesrat 2020):

- Ensuring that the ammunition used for hunting has a fast and sufficient killing effect,
- Minimizing the release of lead from rifle ammunition to the game body.

2 Implementation and objectives of technical discussions

On the initiative of the BfR, national and international scientists from federal and state authorities, universities, research institutions and experts from associations held a series of expert discussions on the definition and interpretation of key terms introduced during the discussions on the amendment of the Federal Hunting Act and also drew up corresponding guidelines describing test procedures for testing the effectiveness of hunting rifle bullets. The aim of the expert discussions was to develop knowledge-based transparent procedures in order to achieve reproducibility in the test procedures and to provide the hunter with appropriate information for the choice of ammunition.

3 Conclusion of the technical discussions

In order to make the effectiveness potential of bullets "measurable" and, if necessary, "reproducible", qualitative and quantitative parameters must be defined. For evaluation, it must be possible to simulate and reproduce these parameters in "test simulants/test media". The core statements agreed upon by the expert panel were summarized and recorded as a respective "conclusion":

Conclusion I: Killing cannot be simulated.

Conclusion II: The effectiveness potential of bullets can be described on the basis of parameters.

Conclusion III: The effectiveness potential of a bullet can be simulated in test simulants/test media, mapped, and evaluated.

Conclusion IV: The expert panel proposes to refer to test simulant/test medium as "tissue simulant" in the future.

3.1 Facts/derivations

The expert panel confirmed the fundamental importance of terminology and definitions for the development of scientifically based criteria as a basis for decision-making in the discussions within the framework of an amendment to the Federal Hunting Act.

The term "killing" is defined and interpreted differently

- in the legal framework,
- in the hunting community,
- in science (e.g., with regard to animal welfare).

For this reason, the expert panel initially identified terms that are largely based on formulations in relevant legal texts:

- Killing
- Animal welfare killing
- Killing in accordance with animal welfare standards
- Ethical hunting (Weidgerechtigkeit)
- Ethical hunting according to the rules of the game
- Ethical hunting shot (weidgerechter Schuss).

In the Federal Hunting Act (BJagdG) it is stipulated in paragraph 1 (3) that "in the practice of hunting, the generally recognized principles of German Weidgerechtigkeit are to be observed". In this context, it remains open what is meant by the term "German Weidgerechtigkeit"? In the draft law of the state government of Baden-Württemberg from 2014 for the introduction of a hunting and wildlife management law, "Waidgerechtigkeit" is defined as the good professional practice of hunting practice and it is stated in a general way that a hunting practice is only ethical if it complies with all legal requirements as well as all generally recognized, written or unwritten regulations and social norms on the practice of hunting, especially with regard to animal welfare, animal health, the protection of natural resources, conduct towards other holders of hunting rights, persons authorized to hunt and the general public, as well as with regard to hunting ethics.

In 2015, as part of the development of a draft Technical Guideline for Hunting Bullets, Kneubuehl (2015) introduced the term "Ethical hunting shot", which he defined as follows: "An ethical hunting shot strikes the carcass in the area that is most certain to cause immediate death."

In an answer of the Federal Government to a small question on the subject of "lead-free hunting ammunition", the term "killing in accordance with animal welfare and hunting" is introduced (Deutscher Bundestag 2013): "Killing in accordance with animal welfare is given when the animal has to suffer as little as possible after being shot and dies as quickly as possible."

The German Hunting Association (DJV 2021) comments on the term "ethical hunting (Weidgerechtigkeit)" as follows:

> "In hunting, the general principle of animal protection law also applies, that animals are to be spared avoidable torment. Nothing else says also the principle of ethical hunting. Killing animals in the context of ethical hunting is recognized in animal protection law as a reasonable reason for killing an animal."

The concept of ethical hunting practice is to be seen legally in a close connection with the concept of "killing", as stated in the Animal Protection Act with regard to hunting in paragraphs 4 and 4a:

§ 4

(1) A vertebrate animal may only be killed under effective analgesia (anesthesia) in a state of unconsciousness and insensibility or otherwise, as far as reasonable under the given circumstances, only under avoidance of pain. If the killing of a vertebrate animal without stunning is permissible within the scope of hunting in accordance with the law on hunting or on the basis of other legal provisions, or if it is carried out within the scope of permissible pest control measures, the killing may only be carried out if this does not cause more than unavoidable pain. Only those who have the necessary knowledge and skills may kill a vertebrate animal.

(2) For the slaughter of a warm-blooded animal applies § 4a.

§ 4a

(1) A warm-blooded animal may be slaughtered only if it has been stunned for the purpose of slaughter before blood withdrawal begins.

The majority of the participants in the expert discussions at the BfR were of the opinion that the term "killing effect" introduced by the responsible ministry (Federal Ministry of Food and Agriculture, BMEL) in the course of the discussions on an amendment to the Federal Hunting Act should be regarded as a so-called "placeholder" in terms of its meaning and has a strong connotation relevant to animal protection. According to Bundesrat (2020), the following is stated in this regard in the explanatory memorandum to the amendment of Article 1 number 6 letter a double letter aa (§ 19 paragraph 1 number 2 letter a and b (BJagdG):

> "From protection, it is necessary that the ammunition used for hunting has a certain impact energy to ensure a fast and sufficient killing effect."
> "In particular, because there are no data on the reliable killing effect [...], from the point of view of animal protection, there is a need to define an impact energy for ammunition, which must not fall below."

3.2 Explanations

3.2.1 Regarding conclusion I: Killing cannot be simulated

In the course of the discussions at the expert meeting, it became clear that the term "killing effect of a bullet" cannot be defined on the basis of the current state of knowledge. The question of how to prove the killing effect of a bullet or how to simulate the killing effect in a medium was answered unanimously by the experts to the effect that this cannot be simulated.

3.2.2 Regarding conclusion II: The effectiveness potential of bullets can be described using parameters

The effectiveness potential of bullets

Data on the effect of bullets determined by the shooting of test simulants/test media cannot be directly transferred to

the animal. What can be measured are physical parameters on the test simulant/medium and on the bullets, from which an effect potential can be derived. For the expert panel, this raised the question of what the effect of bullets is and how the effect of bullets can be described. Four essential indicators were ultimately formed in this context from different technical perspectives:

- Effect of the bullet on the biological tissue,
- Optimum effect of the bullet with an ethical hunting shot,
- Effect of the bullet on the hunted game with suitable point of impact,
- Physical effectiveness potential.

The experts underpinned the respective indicators with the following explanations:

Effect of the bullet on the biological tissue

The effect of a bullet includes those reactions that are produced by a hit on the game.

The reactions are dependent on/of the:

- Physical condition (game type/age class/body type/constitution),
- State of arousal (standing/drawing/pushing),
- Point of impact and course of the shot channel in the game body,
- Effectiveness potential of the hunting bullet,
- Destruction of biological tissue.

The aim of hunting is the killing of the game, which is accompanied by the loss of the game's ability to perceive and feel. Biologically, this is the targeted mechanical destruction of the tissue at a suitable location of the game body and to a suitable extent.

Optimum effect of the bullet with an ethical hunting shot

The optimum effect of the bullet is to be achieved by means of an ethical hunting shot using suitable bullets.[1]

For explanation, reference is made to a slightly modified definition by Kneubuehl (2015):

> "An ethical hunting shot hits the game body in the area that leads directly to death with the greatest possible certainty."

Effect of the bullet on the hunted game with suitable point of impact

The effect of the bullet is largely determined by the point of impact (internal parameters: entry/exit, diameter and maximum cross-sectional area of the wound, direction/angle).

Physical effectiveness potential

The physical effectiveness potential comprises the physical and design properties of the bullet. It can be determined after firing at a test simulant/medium.

What can be observed after firing is the result of a physical energy transfer to the test simulant/medium. "Measurable" is the effectiveness potential of bullets when the effectiveness potential can be adequately described by specific parameters. In summary, the effectiveness potential is the ability of a bullet to perform a certain amount of deformation work (tissue destruction) in the game body or the test simulant/medium.

As the expert panel defined in more detail, the effectiveness potential of a bullet depends on/of:

- The energy of the bullet before the target (included are: bullet mass and bullet velocity before the target),
- Energy conversion in the target (included are: deformation readiness of the bullet, type of change in cross-sectional loading, fragmentation, qualitative and quantitative characteristics of the basic geometry of the cavern),
- The exit energy as a function of the process (included are: bullet residual mass and bullet velocity after the target).

Proof of the effectiveness potential is provided by determining characteristic data and measurable parameters of the cavity in a ballistic test simulant/test medium:

- Indication of the type of test medium,
- Parameters of the cavity (measurable).[2]

Measurable are:

- Cavity length,
- Maximum expansion of the cavity,
- Location of the maximum extension,
- Penetration depth of the bullet,
- Volume of the cavity in the test medium soap

From the characteristic data and parameters of the cavity the following can be derived/ determined by calculation or measurement:

- Volume of the cavity—e.g., calculated via image evaluation for the test medium soap,
- Volume of the temporary cavity—e.g., via image evaluation in the test medium gelatin,

[1] In order to trigger a kill, based on the minimum impact energy, a certain minimum work must be performed at a certain depth of the game. The reference to the choice of "suitable bullets" has also been included in order to include the aspect of the lowest possible game board evaluation.

[2] In the future, the cavity might also have to be defined by a minimum diameter. At present, there are no sufficient results available.

- Crack surfaces of the cavity in the test medium gelatin (segmented),
- Crack lengths in the test medium gelatin (segmented).

From the parameters of the cavity, it may be possible in the future to derive the energy output per path.

3.2.3 Regarding conclusion III: The effectiveness potential of a bullet can be simulated and evaluated in test simulants/test media

The term "effectiveness potential of bullets" alone does not carry the day but must be further defined in terms of its specific physical property by quantitative and qualitative parameters.

3.2.4 Regarding conclusion IV: The expert panel proposes to refer to test simulant/test medium as tissue simulant in the future

The mechanical destruction and strain of a test simulant/test medium can be simulated and also measured by means of a suitable test setup. Mechanical destruction (overstretching, context separation) includes both the material struck and the surrounding material of the test simulant/test medium.

Based on the terms "simulant"/"medium" frequently used in the literature on forensic investigations or publications on bullet behavior, the expert panel discussed, among other things, the question of which term should be given priority: "simulant" or "medium"? Kneubuehl et al. (2008) stated in their standard work "Wound Ballistics":

"Simulants are […] materials that exhibit similar behavior to bullets (e.g., elasticity, energy transfer capability, resistance, etc.) as body tissues when fired upon. They are used for experimental modeling of the physical-ballistic aspect of wound ballistics.

The material must have (approximately) the same density ρ. For example, soap and gelatin have very similar densities to muscle ($\rho = 1.06$ g/cm^3)…".

The experts in the technical discussions at BfR concluded that simulants are substitute media that resemble human or animal tissue in their density and viscosity and are therefore used as a substitute for clarifying ballistic questions, for example in forensics or for ballistic tests. The destruction and elongation in the medium are shown as representative of the effects in the tissue. These effects are a consequence of energy dissipation, which are tolerated in different ways by different types of tissue and for which limits can be set. Since the term "medium" is also used in the relevant literature, the panel recommended that the term be distinguished from terms such as "water", "soil", "air" and agreed to use the terms "test simulant"/"test medium" instead of "simulant"/"medium".

Furthermore, the experts refer to the fact that different tissues cannot be simulated using one test simulant/one test medium. Therefore, they recommend limiting themselves to one test simulant/one test medium as a "tissue simulant".

4 Regarding attachments

4.1 Definition and terminology

In the following, reference is made to Annex 1, where further definitions and terminology are explained in more detail.

4.2 Development of a product profile

The starting point for the development of a product specification were discussions in connection with the plans for the amendment of the Federal Hunting Act, in which, in addition to the requirement for a fast and sufficient killing effect of the ammunition/bullets used for hunting, a minimization of the release of lead from rifle ammunition to the game body was to be stipulated as a goal for the first time. Against this background, a proposal for the development of a product specification for hunting bullets has been drawn up as a result of the technical discussions with the experts.

The aim of the development of a product profile is to be able to evaluate in the future a hunting bullet used to kill food-producing game species in terms of its physicochemical properties and fragmentation.

This draft product specification for shooting food-producing game species (Annex 2) provides the basis and a possible framework for testing bullet characteristics.

This tabular product specification for hunting rifle bullets for killing food-producing game species is divided into:

1. General information on the bullet,
2. Physical datasheet of the test method,
3. Chemical profile of the test method.

A product profile is supplemented by five attachments, which specify the requirements for test methods or refer to special process instructions. These can be adapted to the respective state of the art or initially require targeted research activities. In particular, this concerns the qualitative and quantitative detection of bullet fragments as well as the minimization approach with regard to food safety. (Annex 5: Fragmentation testing). Initial questions are currently being investigated at BfR within the framework of dissertation projects. This work is complemented by research projects with experts from the federal agencies participating in the technical discussions and representatives from universities.

Specific information on fragmentation classes was added following a member survey conducted by the Association of Manufacturers of Hunting, Sporting and Ammunition Weapons (JSM) and Fachverband Groß- und Außenhandel mit Jagd und Sportwaffen e.V.

With the help of this product profile, it is possible to determine the minimum impact energy or maximum application range for a kill that is appropriate for animal protection, depending on the game class and bullet, and to define stages for a gradual minimization of the introduction of metal particles into the game.

The expert panel recommends that the authorities store the product profiles in a publicly accessible database to enable accessibility and to ensure clarity. The extent to which supplementary annexes are added individually or as a whole is left to a decision elsewhere.

The information on the bullets listed in the product profile was considered by the expert panel to be sufficient to also answer questions from reloaders and to develop labeling proposals for the packaging of hunting rifle bullets/ammunition. In the opinion of the participants in the expert discussions at the BfR, such aspects are to be worked out by the economic operators and the associations.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00003-022-01384-y.

Acknowledgements We would like to express our sincere thanks to all the experts involved, who discussed the topic of the expert meeting with commitment and at unusually close quarters, and who worked out the formulations of the documents in a joint effort. The discussions have shown how important it is for different disciplines to exchange information in order to advance this highly complex topic on a scientific basis and thus contribute to the legislative process.

Our special thanks go to all the experts involved Tillmann Möhring[7], Alan Serven[8***], Nico Wirtz[9***], Manfred Tonnier[10], Richard Patterson[9***], Axel Heider[11], Florian Steinberger[11], Klaus Gotzen[12], Ralf Winter[12]

(The experts marked with *** contributed their expertise as independent experts and not as association representatives. Therefore, their mention does not imply the association's endorsement and/or support of all contents, conclusions or objectives presented in the publication) as well as the colleagues involved

Niels Bandick[1], Harald Jungnickel[1], Jutta Tentschert[1], Manuela Kirchner[1], Annett Martin[1], Anneluise Mader[1], Annina Haase[1], Robert Pieper[1]

[7]Deutscher Jagdverband e.V., Chausseestraße 37, 10115 Berlin, Deutschland

[8]Remington Arms Co., LLC, 1816 Remington Circle SW, Huntsville, AL 35824, USA/Sporting Arms and Ammunition Manufacturers' Institute Inc., 11 Mile Hill Road, Newtown, CT 06470-2359, USA

[9]Sporting Arms and Ammunition Manufacturers' Institute Inc., 11 Mile Hill Road, Newtown, CT 06470-2359, USA

[10]Beschussamt Ulm, Albstraße 74, 89081 Ulm-Jungingen, Deutschland

[11]Bundesministerium für Ernährung und Landwirtschaft, Rochusstraße 1, 53123 Bonn, Deutschland

[12]Verband der Hersteller von Jagd-, Sportwaffen und Munition (JSM), An der Pönt 48, 40885 Ratingen, Deutschland.

Funding Open Access funding enabled and organized by Projekt DEAL.

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

Bundesjagdgesetz (BJagdG) in der Fassung der Bekanntmachung vom 29. September 1976 (BGBl. I S. 2849), das zuletzt durch Artikel 291 der Verordnung vom 19. Juni 2020 (BGBl. I S. 1328) geändert worden ist

Bundesrat Drucksache 680/20 (Beschluss) vom 18.12.2020, Stellungnahme des Bundesrates – Entwurf eines Ersten Gesetzes zur Änderung des Bundesjagdgesetzes und des Waffengesetzes. Bundesanzeiger Verlag GmbH

Deutscher Bundestag Drucksache 17/13323; 17. Wahlperiode 26. 04. 2013: Antwort der Bundesregierung auf die Kleine Anfrage der Abgeordneten Dr. Kirsten Tackmann, Karin Binder, Sabine Stüber, Alexander Süßmair und der Fraktion DIE LINKE. – Drucksache 17/13049 – Bleifreie oder bleihaltige Jagdmunition

Deutscher Jagdverband (DJV) 2021: Jagdrecht in Deutschland (https://www.jagdverband.de/rund-um-die-jagd/rechtslage/jagdrecht-deutschland)

Kneubuehl B (2015) Abschlussbericht über die Erarbeitung eines Entwurfs einer Technischen Richtlinie für Jagdgeschosse (TRJ). Bundesanstalt für Landwirtschaft und Ernährung; Projektnummer 314-06.01-2813HS023

Kneubuehl B, Coupland R, Rothschild M, Thali, M (Eds) (2008) Wundballistik. 3. Auflage, Springer Medizin Verlag ISBN 978-3-540-79008-2

Landtag von Baden-Württemberg 15. Wahlperiode Drucksache 15 /578930. 09. 20141 Eingegangen: 30.09.2014/Ausgegeben: 16.10.2014 Gesetzentwurf der Landesregierung Gesetz zur Einführung des Jagd- und Wildtiermanagementgesetzes

Schaller T (2020) Tierschutz und Jagdrecht – unter besonderer Berücksichtigung der Weidgerechtigkeit, In: Martínez (Hrsg.), Göttinger Onlinebeiträge zum Agrarrecht Nr. 05/20

Technische Richtlinie „Patrone 9 mm x 19, schadstoffreduziert" des Polizeitechnischen Instituts (PTI) der Deutschen Hochschule der Polizei (DHPol), Stand: September 2009

Tierschutzgesetz in der Fassung der Bekanntmachung vom 18. Mai 2006 (BGBl. I S. 1206, 1313), das zuletzt durch Artikel 105 des Gesetzes vom 10. August 2021 (BGBl. I S. 3436) geändert worden ist