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PHYSICAL HAZARDS OF FOOD PACKAGING MANUFACTURE

ZAGROŻENIA FIZYCZNE W PRODUKCJI OPAKOWAŃ DO ŻYWNOŚCI

ABSTRACT: Physical contamination includes all material and foreign bodies which have incidentally penetrated foodstuffs. Packaging may become one of the sources of their occurrence. In the present paper, the results of the conducted studies and the conclusions, resulting from their identification as well as evaluation of importance of potential physical hazards which might occur in food packaging production, were presented. The mentioned hazards were indicated by Polish producers and certified in accordance with BRC GS Packaging Materials. The mentioned studies demonstrated also the areas of the enterprises' activity where the physical hazards were identified. They showed the significance of the discussed threats at a given stage of manufacturing process, as well.
Key words: food packaging, physical hazard, significance of physical hazards

STRESZCZENIE: Zanieczyszczenia fizyczne to wszystkie materiały i ciała obce, które przypadkowo dostały się do żywności. Jednym ze źródeł ich występowania mogą być opakowania. W artykule przedstawiono wyniki badań i wnioski z identyfikacji oraz oceny istotności potencjalnych zagrożeń fizycznych mogących wystąpić w produkcji opakowań do żywności, wskazanych przez polskich producentów, certyfikowanych na zgodność z brytyjskim standardem BRC Packaging Materials. Badania pokazały również obszary działalności przedsiębiorstw, w których identyfikowane są zagrożenia fizyczne oraz jaka jest ich istotność na danym etapie procesu.
Słowa kluczowe: opakowania do żywności, zagrożenia fizyczne, istotność zagrożeń fizycznych

INTRODUCTION

Food packages are industrial products, intended for placing food products inside them; they must guarantee health safety of the stored food and ensure health protection of the consumers. The aim of applying the packaging is to protect food against the factors which might cause food deterioration, such as inter alias, light, oxygen access, chemical contamination, presence of microorganisms and mechanical damages (Czerwińska, 2018). In turn, safety is a status which gives a feeling of certainty and calm to the man in a longer time perspective (Rybińska and Galińska, 2014). A package which is intended to come into contact with food should be treated as a product, being independently introduced to the market as well as a product, inherently connected with food (Lisińska-Kuśnierz and Kawecka, 2012). Food packaging production is a global industry, which is characterized by internal diversity and each of its sectors affects individually the situation at the market.

The requirements concerning packaging and articles, destined to come into contact with food are systematically growing. It happens so as the interest of the consumers in fresh products with the extended shelf-life and the controlled quality is constantly increasing. Additionally, it is expected that the packaging is modern and simultaneously safe. It is a challenge to the sector of food packaging and a driving force for development of new and improved ideas of packaging technologies (Barska and Wyrwa, 2017). If we want to ensure a safe food product to our customer, the problems of food safety must refer to all participants of the food chain. It includes also the producers of packaging materials. The participation in the food chain must incline each entity acting at the food market (from the farmers to retail merchants), to preserve the appropriate care and ensure that safety and quality of manufacture of the products are found on respectively high level. It must mean, inter alia, honesty and activity consistent with the binding law,

being demonstrated everyday and guaranteeing such values as safety of the product and its protection, quality, authenticity of the composition and origin, complex information about the product and traceability throughout the whole chain (Wiśniewska, 2017).

BASIC LEGAL REQUIREMENTS DEMANDED FROM FOOD PACKAGING PRODUCERS

Producers of food packaging have to observe the obligatory legal regulations. Consistency of packaging materials with the legal requirements for food producers means, inter alia, that they must know what material would be the best for packaging the specified products (Lenartowicz-Klik, 2020). Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001 on general product safety imposes the obligation to assess the safety of the products, taking into account all the relevant aspects, in particular the categories of the consumers. In Poland, the mentioned Directive is implemented via the Act on 12 December 2003 on general safety of the products. According to this Law, „the safe product is such product, which under the common conditions of use, or under the other conditions which might be foreseen in a justifiable way, with the consideration of the time of the product's use and, also, depending on a type of the product, way of its launching and the requirements of installation and maintenance, does not make any risk to the consumers, or makes an insignificant risk, which might be reconciliated with its common use and considers a high level of requirements concerning human health and life protection". Therefore, when assessing the safety of the product, we have to consider as follows: properties of the product, including its composition and packaging, its effect on other products, appearance of the product, its labelling, precautions and instructions for its use and any guidelines and information relating to the product, being available to the consumer. Besides it, we should analyse the categories of the consumers who are exposed to the risk in connection with the use of the products, and in particular, children and older persons. The product which does not meet the mentioned above requirements is not a safe product and by this, it makes a risk. The serious risk is understood as infringement of the safety requirements, requiring the immediate measures to be undertaken; when analysing such risk, we should consider the direct or later consequences of the product's use, including the degree and probability of the consumer health and life loss, the degree of threat to the particular consumer categories and the possibility of the correct evaluation of the risk by the consumers and the possibilities of its avoidance.

When referring to the food packaging, we should pay attention to the fundamental legal law in this respect, i.e. Regulation (EC) No 1935/2004 of the European Parliament and of the Council of 27 October 2004 on materials and articles intended to come into contact with foodstuffs. The mentioned Regulation is applied in the case of materials and products which – in a ready-to-use state – are destined for the contact with food or remain already in the contact with food and are intended for this purpose. We may, additionally, reasonably expect that they will be brought to the contact with food or the migration of its components to food will happen in the case of their application under normal or foreseeable conditions. Regulation No 1935/2004 refers to Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority (EFSA)[1] and laying down the procedures in respect of food safety. In Article 5 of Regulation 1935/2004, there is a reference to categories of materials. Within the frames of the mentioned groups, we may distinguish, inter alia, plastics, paper and cardboard, metals and alloys and glass, i. e. the raw materials which are used for production of packaging and packaging materials intended to come into contact with food. The reference to Annex I of Regulation 1935/2004 and the indicated groups of materials is also found in the Commission Regulation (EC) 2023/2006 of 22 December 2006 on good manufacturing practice for materials and articles intended to come into

[1] European Food Safety Authority (EFSA) – agency of the European Union dealing with independent advisory scientific activity in respect of existing and occurring threats connected with the food chain

contact with food, indicating that they should be produced in compliance with general and detailed rules of good manufacturing practice (GMP). Good manufacturing practice means those aspects of quality assurance which ensure that materials and articles are consistently produced and controlled to ensure conformity with the rules applicable to them and with the quality standards appropriate to their intended use by not endangering human health or causing an unacceptable change in the composition of food or causing a deterioration in the organoleptic characteristics thereof (Article 3, point (a)). The confirmation of the conformity of the packaging material with GMP by the producer means that the system of quality assurance has been established including: choice of starting materials consistent with the earlier set requirements (ensuring the compliance of finished product with legal regulations), conducting the operations in accordance with the earlier established procedures and the methods of proceeding, ensuring the compliance of the finished product with the fixed procedures and establishment of the quality control system (Pawlicka, Mazańska and Barbarska, 2017).

Regulation 1935/2004 gives, first of all, the basis for development of detailed legal regulations; we should, however, add that only plastic packaging materials were comprehensively regulated at the EU level by the Commission Regulation (EC) No 10/2011 of 14 January 2011 on plastic materials intended to come into contact with foods. The remaining packaging materials are evaluated on the grounds of the regulations of a given country, adopted later on by the successive states, or of the regulations intended principally for other categories of products but employed also for the discussed type of packaging. The requirements concerning paper in the European Union were regulated by German Federal Institute of Risk Assessment (BfR – Bundesinstitut Für Risikobewertung), subordinate to Federal Ministry of Food, Agriculture and Consumer Protection of Germany when developing the Recommendation XXXVI – Paper and board for food contact (2019). Gradually, with the time, the successive countries adopted the mentioned recommendation concerning paper and cardboard as binding and at present it has become the basic interpretation which the producers and laboratories in area of paper product safety are referring to. The successive regulations concerning paper were created by the Federation of the European Paper Industries (CEPI)[2]. In March 2019, CEPI and FEFCO (European Federation of Corrugated Cardboard Producers), International Confederation of Paper and Cardboard Processors in Europe, paper suppliers and other associations, developed the new Guidelines concerning articles and materials made from paper and cardboard, intended to come into contact with food. The guidelines concern paper and cardboard products and tissue products (paper towels and serviettes) and they are expected to increase the support for the producers so that the production would be consistent with legal rules and the products would be safe for the customers (Werner, 2020). In the Guidelines, there were analysed the problems concerning the requirements of compliance with the law regulations in respect of components and manufacturing processes, tests of compliance and their methodology and frequency, guidelines concerning traceability and labelling of the products and, also communication in the supply chain. In turn, glass packages do not have developed legal requirements, being directly addressed to this material, so the attempts are undertaken to combine glass with ceramics which is subordinate to the requirements of the Commission Directive 2005/31/EC of 29 April 2005 in respect of declaration of compliance and criteria of effectiveness of the analytical method in the case of ceramic products, intended to come into contact with food. Metals are subjected to control on the grounds of guidebook: „Metals and alloys used in food contact materials and articles. A practical guide for manufacturers and regulators, 2013"). The guide was developed by the Committee of Experts on Packaging Materials for Food and Pharmaceutical Products and published by the European Directorate for the Quality of Medicines &Health Care (EDM) as guidelines for producers of metal packaging.

[2] CEPI is the all-European association, representing textile and paper industries. CEPI, via national associations, agglomerates several thousand papermaking plants in the whole Europe, which produce paper, cardboard, cellulose mass and other biodegradable products (from technology of wood fibres to advanced designing of paper)

The mentioned above rules and recommendations are aimed at support of national political decision-makers in order to increase harmonization of technical standards between the countries.

PHYSICAL HAZARDS IN PRODUCTION OF FOOD PACKAGING

Physical contaminants of food include all materials and foreign bodies which have incidentally penetrated foodstuffs (Sitarz and Janczar-Smuga, 2012). When considering various ways of food contamination with foreign bodies, we can classify the physical hazards in a following way:

- those which appeared in the product together with the raw materials (e. g. sand, sticks, leaves),
- those present in the raw materials (e. g. fragments of bones, fruit stones),
- those which were transferred to the products during the technological processes (e.g. metal elements, plastic elements),
- those which appeared in the products due to failure in observing the sanitary standards by the staff and of applying the correct protective clothes (e.g. jewellery, hair, buttons),
- those which appeared in the product as a result of non-observing the principles of good manufacturing practice (GMP) (e. g. glass, pieces of gypsum or paint),
- those which were intentionally introduced to the products (Kołożyn-Krajewska and Sikora, 2010).

Analogically, with small exceptions, the mentioned sources of hazards and the hazards themselves may be transferred to the packaging and their producers as the participants of the food chain.

The source of foreign body in food may be, inter alia, the packaging. Under normal conditions, the foreign bodies do not occur, so they come inside the product due to negligence or failures, taking place mainly during manufacture and storage (Wiśniewska, 2018). Foreign bodies represent various levels of hazard; apart from it, a degree of their elimination is also different. The basic physical hazards include: glass, wood, stones and sand, metal elements, plastic, elements of jewellery, nails and hair.

The sources of physical hazards may be different, commencing from raw materials, via the manufacturing process, elements of machines and equipment and packaging elements, to the staff, performing manufacture and storage work (Kołożyn-Krajewska, 2013; Krzysztofik, 2016). The detailed presentation of physical hazards and the sources of their origin are given in Table 1.

THE RESULTS OF THE STUDIES

The studies were carried out in the second half of 2019, using survey questionnaire which was sent to the enterprises, certified on the compliance with BRC GS Packaging Materials[3].

[3] BRC GS Packaging Materials, as being developed by British Association of Retailers is – in Poland – the most popular certified voluntary standard concerning quality and safety in packaging sector; during performance of the mentioned studies, 5th version of standard – Packaging and Packaging Materials was a binding document. At present, the obligatory version is BRC Packaging Materials 6:2019

TAB. 1. PHYSICAL HAZARDS AND THE SOURCES OF THEIR ORIGIN

Type of hazard	Source of the hazards
Glass	Windows, electric bulbs, glasses, watches, screens
Wood	Pallets, mixing devices (agitators), tables
Stones, sand, dust	Raw materials, cleaning process, elements of buildings (e. g. dropping wall plaster)
Metal	Machines and equipment, buttons, edges, needles and other tools
Plastic	Machines and equipment, elements of work clothes, pallets, agitators, staff (objects, worn in the pockets)
Hair, nails	Staff

SOURCE: KOŁOŻYN-KRAJEWSKA, 2013; EMBLEM AND EMBLEM, 2014

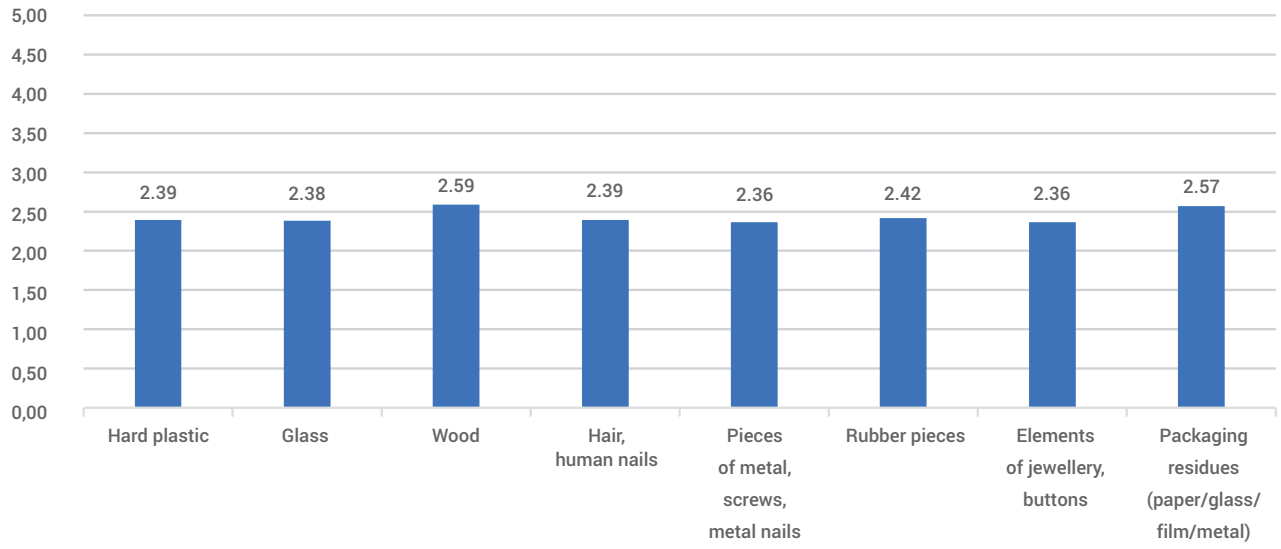

FIG. 1. SIGNIFICANCE OF PHYSICAL HAZARDS (SCALE 1-5)

SOURCE: OWN ELABORATION

The survey was participated by 122 enterprises, producing packaging from paper and cardboard, plastic, glass and metal. Within the frames of the studies, the enterprises were asked to indicate which physical hazards – according to their opinion – were most significant for the safety and quality of packaging (where 1 meant decisively insignificant hazard whereas 5 meant decisively relevant hazard). According to the respondent in general, the significance of all hazards was found on a similar level (Fig. 1). The enterprises indicated wood (2.59 in 5-score scale) as the most significant hazard. The source of wood includes pallets, agitating devices or die-cut forms. Almost identical level of significance was indicated for packaging residues which would be not appropriately separated in manufacturing process. It includes the so-called „hairs", i.e. thin threads of film, and, also, pieces of paper and cardboard, metal filings and very small glass particles. Successively, the enterprises indicates such hazards as rubber pieces, hair, human nails, elements of hard plastic or glass, metal pieces, screws, metal nails, buttons and jewellery elements. At the same time, the respondents had the possibility to indicate the

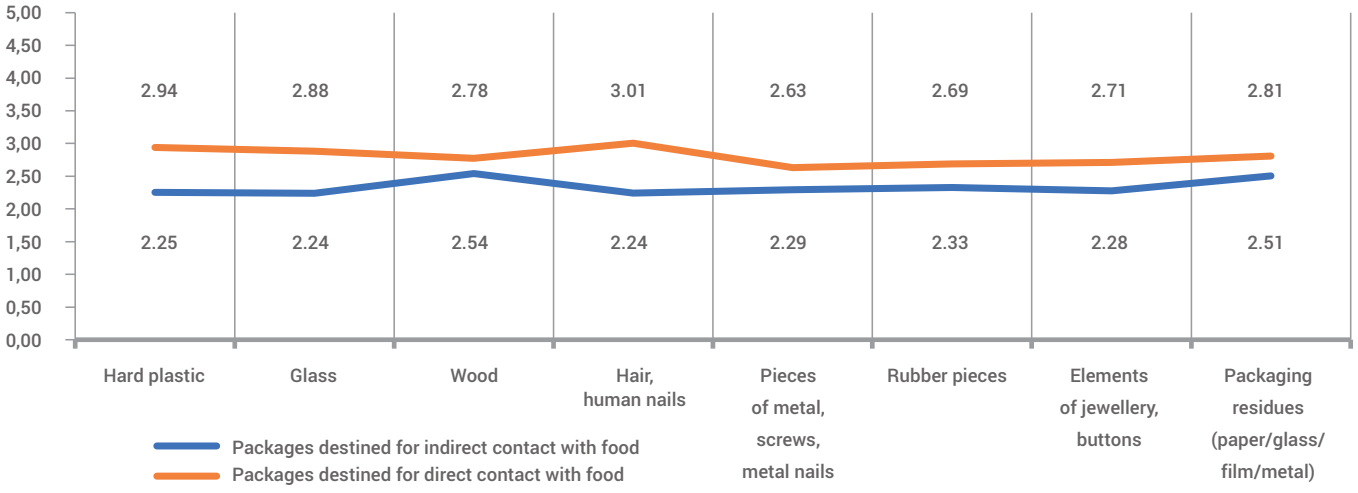

FIG. 2. SIGNIFICANCE OF PHYSICAL HAZARDS WITH CLASSIFICATION ACCORDING TO DESTINATION OF PACKAGING (SCALE 1-5)

SOURCE: OWN ELABORATION

additional physical hazards but they did not do it. It could include, for example, sand, elements of building such as plaster, or insects. The mentioned attitude may result from a very good state of infrastructure, high sanitary standards and high awareness of the employees but also, from a small awareness of the importance of different physical hazards in manufacturing process. The respondents could indicate such hazards but they could assess them as having a low importance.

Fig. 2 shows the significance of the indicated above hazards with classification into packaging intended for direct and indirect contact with food. In case of all hazards, the consumers recognized that the significance in the case of direct use packaging was higher than the importance of materials used in indirect contact with food. In the case of the direct contact packaging, physical hazards in a form of hair and nail elements (significance level 3.01), then hard plastic (2.94) and glass (2.88) were most significant. In the case of packaging for the indirect contact with food, the most relevant hazard came from wood (2.54) and packaging residues which have not been properly separated (2.51).

The tested enterprises had also the task to indicate the stage of manufacturing process where the physical hazards were identified (Fig. 3). All the enterprises identified physical hazards in the following areas: storage of raw materials, implementation of the particular stages of production and storage of finished products. The smallest number of enterprises identified the physical hazards in area of the storage of semi-products (74% of enterprises).

Besides it, the task of the enterprises was to assess the significance of physical hazards, indicated in the respective areas (scale 1-5, where 1 meant decisively insignificant hazard whereas 5 meant decisively significant hazard). The summary of the assessment of significance of physical hazards in the particular areas was given in Fig. 4. The enterprises indicated implementation of manufacturing processes as the area where the occurrence of physical hazards is most significant (significance level 2.77). Besides it, raw materials and packaging process were the most relevant source from a viewpoint of identified physical hazards (significance at the level of 2.57 and 2.56, respectively). On the other hand, the least significant area in the context of physical hazards, as indicated by the respondent included areas of loading and transport of the products to the customer (the product is found, most frequently, packed on the pallets and protected by the packaging of stretch

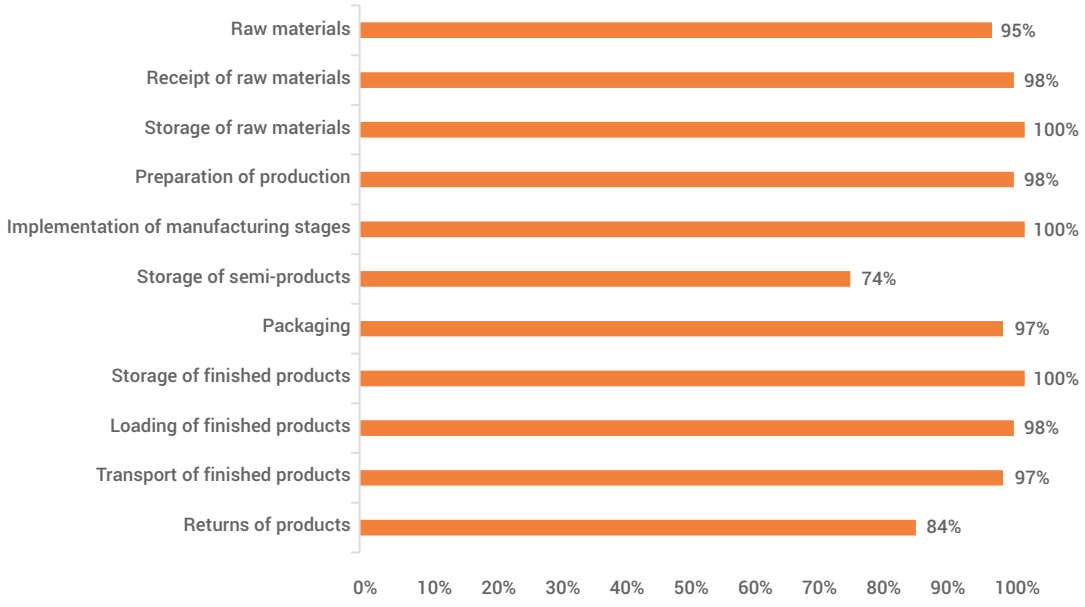

FIG. 3. AREAS OF ACTIVITY WHERE THE ENTERPRISES IDENTIFIED PHYSICAL HAZARDS (IN %)

SOURCE: OWN ELABORATION

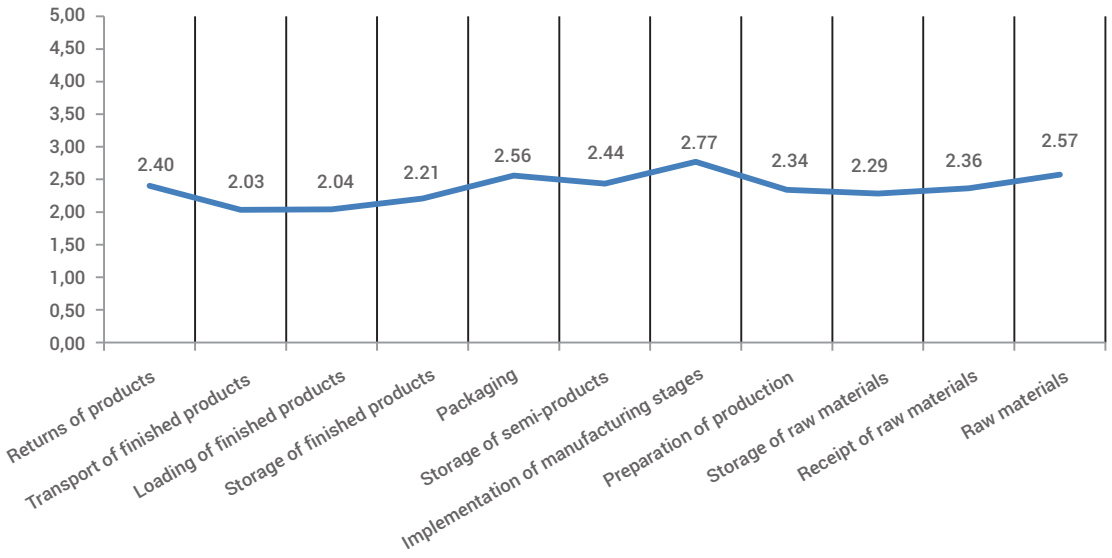

FIG. 4. SIGNIFICANCE OF PHYSICAL HAZARDS IN RELATION TO STAGES OF MANUFACTURING PROCESS (SCALE 1-5) SOURCE: OWN ELABORATION

film type; by this, the possibility of foreign bodies" penetration inside seems to be much limited).

CONCLUSIONS

The appropriate and comprehensive identification of physical hazards in production of packaging intended to come into contact with food is extremely important from the viewpoint of food safety and by this, consumer health and life. The results of the conducted studies among the producers of food packaging showed that the producers identified the most significant physical hazards and assessed their importance at the medium level. It may confirm the justness of areas, which require control, as indicated by BRC GS Packaging Materials. Standard imposes a special supervision of glass, wood and hard plastic, puts the pressure on the appropriate maintenance and repairs of machines, stresses the role of observing the principles of hygiene in respect of working clothes and jewellery (inter alia, cover of head, gloves, ban on jewellery and nail tips or lacquering the nails). In relation to the enterprises which have not introduced any quality and safety assurance system and have a lot of quality troubles or a great number of complaints, the results of the tests may be the confirmation of the justness of implementing and certifying the quality and safety management systems.

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