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AUTHENTICITY OF FOOD PRODUCTS IN THE POLISH MARKET CHECKED DURING 2005 -2012

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ABSTRACT

Background. Food fraud/adulteration has ever increasingly become a dominant food issue of the modern world in both developed and developing countries. It is presumed that globalisation is mainly one of the underlying reasons.
Objective. To assess and analyse the occurrence of food fraud on the Polish market during 2005-2012.
Material and Methods. Adulteration of foodstuffs was determined from official food inspections carried out by the Agricultural and Food Quality Inspection (IJHARS) in 2005-2012. On average, foodstuff manufacturers inspected ranged from 1300 companies in 2011 to 3000 in 2006. The amount of results so collected, allowed a meaningful assessment to be thus made of food fraud on the Polish market.
Results. Food fraud was found to vary in the Polish market for the specific areas researched (ie. organoleptic properties, physico-chemistry and labelling) as well as in the agri-food sector. Levels of food fraud were not significantly different to those observed in other countries.
Conclusions. Appropriate control measures, at both national and international levels, are thereby indicated to halt the adulteration of foodstuff products that constitute a health hazard or pose a life-threat to consumers as well as constituting a financial fraud.

Key words: *authentic food, food fraud/adulteration, food quality, organoleptic properties, labelling, plant derived foodstuffs, animal derived foodstuffs*

STRESZCZENIE

Wprowadzenie. Zjawisko fałszowania żywności staje się coraz bardziej dominujące we współczesnym świecie. Dotyczy ono zarówno krajów rozwijających się jak i rozwiniętych. Za główną jego przesłankę uznaje się globalizację.
Cel. Celem artykułu była analiza i ocena występowania zjawiska zafałszowania produktów spożywczych znajdujących się na rynku polskim w latach 2005-2012.
Materiał i metody. Oceny zjawiska zafałszowania produktów spożywczych dokonano na podstawie analizy wyników badań produktów spożywczych pobieranych podczas kontroli przeprowadzonych w latach 2005-2012 przez Inspekcję Jakości Handlowej Artykułów Rolno-Spożywczych (IJHARS). W okresie tym Inspekcja kontrolowała rocznie przeciętne od 1300 w 2011 roku do 3000 w 2006 roku przedsiębiorstw produkujących produkty spożywcze. Liczba wyników badań pozwoliła na dokonanie miarodajnej oceny żywności na rynku polskim, pod względem jej zafałszowania.
Wyniki. Analiza wyników badań kontrolnych żywności znajdującej się na rynku w latach 2005-2012 wykazała zróżnicowaną skalę zafałszowania żywności na rynku polskim w poszczególnych obszarach badawczych (cechy organoleptyczne, parametry fizykochemiczne, znakowanie) oraz sektorach przemysłu spożywczego. Poziom ten nie odbiega jednak istotnie od rozmiarów tego zjawiska w innych krajach.
Wnioski. Uzyskane dane wskazują na potrzebę działań kontrolnych zarówno na poziomie krajowym jak i międzynarodowym w celu zahamowania praktyk fałszowania produktów spożywczych niebezpiecznych dla zdrowia i życia konsumentów, a także finansów.

Słowa kluczowe: *autentyczność żywności, fałszowanie produktów spożywczych, jakość żywności, cechy organoleptyczne, znakowanie, żywność pochodzenia roślinnego, żywność pochodzenia zwierzęcego*

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INTRODUCTION

Increasingly, the problems of food quality and fraud have grown with the dynamic development of global trade in foodstuff products, the lengthening supply/distribution chain and the greater anonymity of the food market.

Fraudulent food has been around for hundreds if not thousands of years [4]. It is however only within the last 200 years, during the industrial revolution and the rise of the 'anonymous consumer' concept/model that a real explosion of this phenomenon has occurred. At present, the issue of food fraud is being intensively dealt with by institutions at the national, regional (EU) and global (Codex Alimentarius) levels.

Investigating and assessing food fraud on the Polish market forms an important part of the surveillance undertaken by the Agricultural and Quality Inspection (IJHARS) within their remit on the product quality of commercial agri-foodstuffs. Through this, it is understood that characteristics of agri-foodstuffs include organoleptic, physico-chemical and microbiological properties related to manufacturing technology, size or weight, and the requirements arising from manufacture, packaging, presentation and labelling not covered by sanitary, veterinary or phyto-sanitary stipulations [10].

Commercial quality control of foodstuffs covers 3 basic features: organoleptic properties, physico-chemistry and package labelling which is defined in the 'economic consumer safeguards' formulation. Irrespective of this, food must meet appropriate requirements of health and nutritional quality which is defined as the so called 'health safety'. This means that foodstuffs cannot contain ingredients or substances hazardous to health or those are life threatening to the consumer and, furthermore, it should have biologically optimal proportions of nutritional components [8]. Fulfilling these conditions constitute the criteria for food safety.

Current technological advances observed in foodstuff manufacture are paralleled with progress in food fraud. The methods of adulteration depend on the food type and the technological means of manufacture which change according to advances made in such production processes. As a result, more sophisticated investigative methods are constantly being needed to detect food fraud [3].

The aim of this article is to determine the level of food fraud in the Polish market based on surveillance studies carried out by the IJHARS laboratories during 2005-2012.

MATERIALS AND METHODS

Analysis and assessing food fraud on the Polish market was performed by IJHARS staff from foodstuff surveillance conducted during 2005-2012. In this time, from 1300 inspections in 2012 to 3000 in 2006 were carried out at food manufacturers. On average 5000-5500 samples of foodstuffs were taken. The analyses were undertaken by IJHARS laboratories with PCA accreditation (Polish Accreditation Centre) to ensure result quality. Around 30,000 to 35,000 physico-chemical parameters were measured. Such large numbers of results have thus enabled a meaningful assessment of food fraud to be made.

RESULTS AND DISCUSSION

MAIN AREAS OF FOOD FRAUD

The main areas of food fraud consist of the following:

Changing the raw materials

This represents one of the main areas of food fraud and, for example, can occur by deliberately adding cheaper meat or animal protein in cold meat products or using meat injected with collagen. Such counterfeiting can be most commonly detected by using the Polymerase Chain Reaction (PCR) that can determine and quantify the meat raw material if any are concealed by the manufacturer. This technique can also detect any raw materials present from plant sources eg. soy.

Adding mechanically deboned meat (MDB)

This is obtained as residual meat tissue that has been mechanically separated from bone for either pork or poultry. Such additions affect both the foodstuff production costs and its nutritional value. Meat products that consist of MDB should be regarded by consumers as being of low quality and having shorter expiry dates. When investigating for undeclared MDB material, the calcium content can be used for the initial screening of foodstuffs suspected of being adulterated which, if positive, are then subjected to additional microscopic analysis.

Colouring additives for improving foodstuff appearance

Making food choices is very often governed by visual assessment. In order to achieve a desired appearance when using various raw material substitutes, manufacturers more frequently use colouring additives; for instance in pasta, non-alcoholic beverages, cheese, fish and meat.

Altering the fish species

These analyses are more frequently undertaken because the more popular and expensive types of fish are substituted with those less well known and cheaper. For detecting such fraud, sarcoplasmic profiling is per-

Table 1. Main irregularities in commercial quality observed in the bread and pasta (2005-2012)

Foodstuff products / Types of irregularities
Bread
• A lower mass of product to that declared. • Incorrect proportions and structure/composition of ingredients to those declared. • A lack off, or incorrect description of the bread type according to the sort of flour used (eg. mixed, wheat or rye). • Absence of the percent composition of a given ingredient described within the product name, eg. wholemeal rye flour, sunflower seeds in wholemeal bread. • No information about any allergenic ingredients, eg wheat flour, sesame seeds. • Providing incorrect standard values for bread eg. in rye bread when the amounts of wheat and rye flour demonstrate a mixed composition. • Placing the conventionally used term 'EKO' within the product labelling suggesting thereby that it is organically produced.
Pasta
• Whenever turmeric spice is allegedly added but is undetectable in the taste and aroma. • Incorrect surface appearance, deformation and/or rupture. • Unretained shape or form after cooking or being undercooked despite using recommended preparation times. • Not in accordance with the appropriate properties of the product after cooking (falling apart, excess viscosity). • Lowered contents to those declared. • The presence of ordinary wheat flour in pasta declared as being made from durum flour. • Contamination by minerals (eg. sand). • Labels misinforming the customer about the product profile and/or name, eg; (a) 'homemade pasta' containing ingredients which are not normally used at home (tumeric or products with Vitamin A). (b) 'homemade pasta' manufactured without eggs but with replacement flavouring. (c) 'homemade pasta' containing food flavouring manufactured by the latest technology; (d) 'best quality guarantee', 'traditional taste, 'guarantee of quality and taste a many years of experience and tradition'; descriptions suggesting special qualities compared to others with the proper documentation. (e) 'flavoured pasta' without any actual flavour. (f) applying two different package descriptions eg. 'egg pasta' on the front and Just 'pasts' on the back which misleads the consumer. • Misleading the consumer on content, eg. (a) In 'egg pasta' no information about the egg ingredient, (ie whether eggs, powdered eggs, egg mass), only the terms like 'beaten eggs' or 'whole' eggs' included. (b) Using terms like 'no preservatives' or 'no food colourings' which mislead the consumer as legal requirements not in fact ban such substances.

formed using isoelectric focusing (IEF) for comparing the patterns of separated protein with those from known standard fish types.

Adding phosphorous compounds

The reasons for adding the above to meat, fish and their products thereof, are to increase their water retention/absorption, thus providing a product with a greater mass. Such fraudulent practices can be discovered by performing thin layer chromatography (TLC) separation of the phosphorus compounds.

Adding non-dairy fats to dairy products

Methods for detecting these are used in the fats from dairy products such as butter, cream, milk or powdered milk. When positive, further confirmation is sought by using the following:

- phytosterol detection (ie. plant-based sterols)
- tocopherol and tocotrienol analysis for identifying palm oil additives
- methods for determination of fatty acid content

In current practice for dairy product surveillance, particular stress is placed on detecting fraud in regio-

Table 2. Main irregularities in commercial quality observed in the fruit juices and nectars/concentrates (2005-2012)

Physico-chemistry features
• Lowered 'millimoles NaOH consumed /100 ml'(ie. reflection of amino acid content) and ash content to that declared in apple juice made from concentrates. • General acidity higher than that declared (as apple acid) in orange juice made from a concentrate, • Elevated citric acid compared to d-isocitrate. • Increased water-soluble pectin.
Labelling
• Given information suggests that a product has specific properties eg. 'no preservatives' for apple juice directly pulped or for raspberry nectar where it is illegal anyway for it to contain preservatives. • Missing items in the list of manufacturing ingredients eg glucose-fructose syrup in apple-morello cherry juice manufacture from fruit concentrates, citric acid. • Supplied information like 'rich in natural Vitamin C' or 'with Vitamin C' for a given product to which ascorbic acid is added during manufacture thus suggesting that the source of this vitamin are the fruit itself. • Absence of the percent composition of a given ingredients described within the product name eg apple-morello cherry juice produced from fruit concentrates.

Table 3. Main irregularities in commercial quality observed in the dairy products (2005-2012)

Organoleptic properties
• Abnormal taste, aroma and consistency.
• Variable colouration, budding in cheeses.
• Abnormal consistency in semi-liquid products (eg cream, cream cheeses) or a foreign taste and aroma of cream cheese).
Physico-chemical features
• Lowered or elevated average levels of fat.
• Presence of foreign fats (eg vegetable fat) or plant sterols.
• Increased water content, especially in cream cheeses.
• Decreased protein content in most dairy products.
• Butter adulterated with vegetable fats.
• Lowered net mass (eg rennet cheese).
• Increased freezing point of water (pasteurised milk).
• The presence of cow's milk in goats' cheese.
• Reduced bacterial numbers of *Lactobacillus subsp. Bulgaricus.*
Labelling
• A longer sell-by date than that according to standards.
• Not all manufacturing ingredients are specified (eg calcium chloride).
• Labelling a product as 'Class I' when the manufacturer does not designate such a quality class.
• Specifying ingredients that were not used in the manufacture, whether labelled on lists or graphics, eg fruit, vegetables.
• Providing incorrect percent composition of basic ingredients (eg cheeses used in processed cheese) as compared to the manufacturer's recipe.
• No information on treatment processes used in product manufacture (eg pasteurization, homogenisation).
• Quantitative information is lacking on a given ingredient stressed in the product name; the so called QUID.

Table 4. Main irregularities in commercial quality observed in the processed meats (2005-2012)

Processed red meat products
Organoleptic properties
• Abnormal appearance (slippery surface, altered colour).
• Inappropriate aroma and jellified areas visible in cross section.
Physico-chemical features
• In products declared to be of pork origin, the presence of other raw material sources eg from poultry, beef, including MDB meat.
• Presence of bone fragments.
• Elevated amounts of water, fat and salt.
• Lowered protein content.
• Presence of undeclared nitrates/nitrites and phosphates.
Labelling
• No information on every raw material used in product manufacture (eg MDB poultry, smoked flavourings, water, pork rind, starch, yeast extract, pork fat, flavour promoters, thickening agents).
• Information lacking on allergenic ingredients present eg soy protein, mustard and celery.
• Unclear labelling of finished product (eg no manufacturing or food-processing information like whether the product is smoked, baked steamed or homogenised).
(a) Misleading information provided to the consumer.
(b) Regarding a product type, for instance, using trade names such as 'ham' to describe such a product containing finely milled ingredients consisting of 50% pork-fat products
(c) In food processing methods used, for eg, adopting descriptions like traditional, home-made, farm produce, tradition and taste, traditional taste when the required documentation to confirm such thigs is lacking.
Processed poultry products
Organoleptic properties
• In products made from meat-fat material with additional homogenisation, suggesting the presence of whole muscle tissue.
Physico-chemical features
• Presence of undeclared pork ingredients.
• Presence of undeclared starch, soy products, phosphates.
• Elevated levels of water, fat and salt.
• Decrised declared protein content (up to 15%),
Labelling
• Not including all raw materials used in product manufacture (eg water, flavourings, MDB meat, pork, flavour promoters, thickening agents.
• Adopting a name misleading the consumer eg; (a) 'Poultry loin', suggesting a link with pork (b) 'Olde Polish Style Chicken' when the raw materials also contain pork when they should be just from poultry.
• Incorrect (decreased) meat content.
• The chicken meat content of a product's ingredients is missing.

Table 5. Main irregularities in commercial quality observed in the fish and processed fish (2005-2012)

Fresh fish
Fresh fish belongs to those foodstuff groups usually demonstrating the largest transgressions regarding quality. This stems from the sensitivity during transporting such foodstuffs of short consume-by dates or from placing low quality fish products on the EU market from other countries eg mainly from Asia. *Organoleptic properties* • Presence of residues (ie. peritoneum, blood clots, mouth parts, heart, stomach and tail fins). *Labelling* • Fish species not provided on goods. • Fishing location not given. • No labels in Polish and/or illegible labelling.
Processed fish
Organoleptic properties • The product ingredients do not match the declared contents of vegetables and spices and other supplements that are absent. • Sardines of different sizes disorderly packed making separation difficult, some sardines with disrupted meat showing visible internal tissue. *Physico-chemical features* • Lowered fish meat content (by up to 30% to that declared by manufacturer). • Elevated glazing content (dup to 9.1%). • Decreased basic ingredient content eg vegetables. *Labelling* • Not all the raw ingredients used in manufacture are listed such as; salt, sugar, vegetables, spices and extracts supplements. • No quantitative information of ingredients within the product name eg. vegetables, prunes, ground spices. • Adopting information misleading the consumer such as: • Omitting to mention that added vegetables were dried. • Stating two different cuts of fish at the same time eg fillets and chops. • Incorrectly adopting the name 'Mattias' for herrings fished in October after the first spawning. • When stated 'Produce of Poland' when the main ingredient comes from the North East Atlantic. • The food processing method is not given (eg. marination, boiling, frying) in given products eg for sterilized fish preserve. • Information lacking on the net mass of fish after separation.

nally produced cheeses like 'oscypek' (smoked ewe's milk cheese), 'redykolka' (a derivative of the previous) or 'bryndza' (sheep milk cheese) made in the Tatra mountains which are officially registered in the EU list of name-protected foodstuff products. For detecting fraud when cow's milk is added to sheep or goats milk, then fat separation methods are employed followed by identifying milk protein fractions (γ-casein).

Refined oil additives in olive oil

For investigating adulterated olive oil, methods for discriminating between added refined oils and those present from cold-pressed olive oil are used. These are based on determining 3,5-stigmastadiene which is a product arising during the refining from the dehydration of β-sitosterol. Additionally, the trans-isomer content is measured, whose presence may indicate that high temperatures have been used during processing. This becomes more important in extra virgin olive oil which probably has the best legal safeguards of all vegetable oils in the EU [1, 2].

EXTENT OF ADULTERATION IN FOODSTUFFS

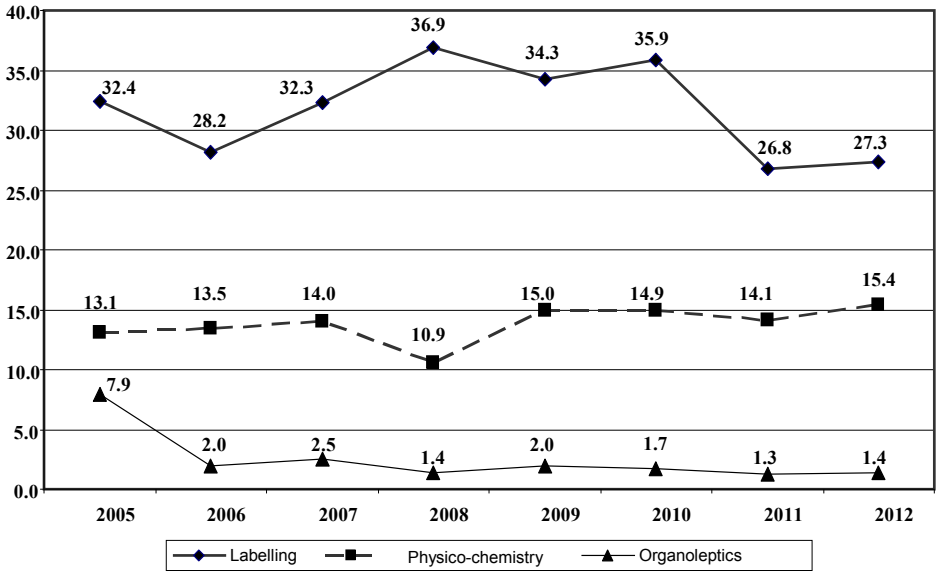
Assessing foodstuff quality control in terms of irregularities/transgressions and fraud is conducted in 3 ways:

- organoleptic properties (ie. taste, aroma, colour, appearance, consistency)
- physico-chemical characteristics that vary according to foodstuff product group such as fat, water, protein, carbohydrate, salt, sugar, humidity, volume, acidity etc.
- foodstuff labelling.

Foodstuff organoleptic forms the initial part of the foodstuff assessment that usually does not provide an unequivocal answer if fraud is present, although some detected irregularities may have arisen from fraud. Confirmation of fraud is only achieved by detecting irregularities in the physico-chemical parameters and the foodstuff labelling. In the former, 70-80% cases of irregularities constitute foodstuff fraud [5]. This is made with reference to the original definition of *Krauze* [7], from 50 years ago, where fraud is taken as misleading the consumer through changing an ingredient(s) of high quality to one of a lower quality or 'false labelling' ie. misrepresentation of the actual content, or manufacturing place, date and method together with properties and nutritional value. Foodstuff labelling is of thus of economic importance as well as being important to the consumer.

Organoleptic assessment

In 2005, irregularities for this area rose by 7.9%, mainly in foodstuffs such as butter (56% of surveyed batches), fish products (14%) and poultry (11.8%).



Source: Based on own presesentation from results obtained by IJHARS inspections during 2005 – 2012.

Figure 1. Inspected foodstuff batches showing transgressions according to quality control parameters as found during 2005-2012 (in %).

However during 2006-12, such levels were 1.5% on average (Figure 1). Put in a different way, in 2005, there was one in 12 transgressions in foodstuff products, whereas during 2006-12 this had decreased to one in 60. Most of the transgressions in plant derived products occurred in 2006, 2008, 2009 and 2012 whilst those in animal products were in 2005, 2007, 2010 and 2011.

Physico-chemical characteristics

During 2005-12, irregularities for the above were noted in 13-15% foodstuff batches under surveillance and their rises have been small but steady, from 13.1% in 2005 to 15.4% in 2012.[1] A satisfactory result of 10.9%[2] was achieved in 2008 resulting from relatively favourable outcomes in physico-chemical studies on red meat products. Physico-chemical transgressions in meat product batches for 2008 were 5%, but were 11.5% in 2010 and 23.5% in 2012.

Transgressions in foodstuffs of animal origin were found to be the highest during 2008-13 with 11.5% recorded for 2008 and 17.6% in 2012, and the highest amounts found in 5 out of the 8 years of this period. Foodstuffs derived from plants however showed batch transgressions in physico-chemical parameters of 11.7% in 2007 to 13.4% in 2006.

The preponderance of fraud in foodstuffs derived from animals over those from plants, reached levels of even 6% in 2012. Only during 2009-2011 were there more transgressions in plant derived foodstuffs than animals.

Generally speaking the authenticity of plant derived foodstuffs was higher than those of animal origin by around 1.5-2.0%.

Foodstuff labelling

This area showed the most transgressions, which varied from 26.8% in 2011 to 36.9% in 2008. Within the study time frame, various trends could be discerned. Transgressions rose from 32.4% in 2005 to 36.8% in 2008, followed by staying steady at 35% over 2008-10 after which it significantly fell to 27% in 2011-12.

Fraud in the physico-chemistry from plant derived foodstuffs was higher than those originating from animals. In terms of foodstuff labelling, there were more transgressions in plant derived foodstuffs than animal ones, differences being from 0.7% in 2011 to 9.1% in 2005.

FOODSTUFF FRAUD ACCORDING TO FOOD TYPE

Levels of authenticity and fraud varied across food types as well as quality control parameters.

Organoleptic properties

Most transgressions in this area occurred in processed fruit and vegetables, which during the study period

[1] In the first half of 2013, physico-chemical transgressions for foodstuffs exceeded 16% and for the whole of 2013 were 19.3% indicating a deterioration in these quality control parameters over 2008-13.

[2] Surveillance over bread has been omitted from the calculations, which in 2008 constituted over 50% of all foodstuff products derived from plants and 30% from overall surveillance from which 0.5% were found to be transgressions. In terms of surveillance over just bread, then transgressions in 2008 amounted to 7.6%.

(2005-12) so in time slot comprising eight periods / years of control was present 7 times on the list of the 5 most transgressed foodstuffs. Bread and baked products were found six times on the list and pasta 5. Amongst the plant derived foodstuffs that frequently appeared were food concentrates, cereals, non-alcoholic beverages and herbs/spices (condiments). Foodstuffs of animal origin present on the list included dairy products (7 times), poultry (6 times) and butter (4 times). Whether foodstuffs were genuine was also questioned in fish and fish products along with processed red meat and eggs.

Physico-chemical characteristics

For plant derived foodstuffs, fraud was found in cereals (5 times present on list), pasta (5 times), frozen and processed vegetables (5 times) and 3 times for respectively grape/wine products, breadcrumbs, honey and beer. Cereals were found overall to have the most fraud, which is of significant import as these products form the dietary basis for the majority of consumers.

Fraud detected in foodstuffs of animal origin included butter, milk fats and dairy products (5 times), processed fish (5 times), processed red meat (4 times), processed white meat (3 times), fish marinades (3 times) and remaining processed meat products (8 times). In all, the dominant foodstuff types in this group were processed meat, and dairy and fish products. Eggs were only once present on this list.

Foodstuffs labelling

This area had the most numerous transgressions. For the plant derived foodstuffs, the most common were bread (4 times), pasta (3 times) and twice for breadcrumbs and fermented wine products. In addition, other frequently appearing ones were olive oil, juices, nectars and dried fruit. In foodstuffs of animal origin, the most common transgressions noted were for processed red meat (11 times), processed fish (7 times) and 3 times respectively for delicatessen products, butter and fat spreads. As opposed to the many foodstuff types of plant origin, transgressions in animal derived ones were confined to just processed red meat and processed fish.

The level of transgressions in food labelling is of concern. In many batches, levels reached even over 10%. During 2005-12, of the 80 inspections that had the biggest transgressions, every second batch of products was found to be incorrectly labelled in 24 inspections. In at least 1/4 product batches (25%), incorrectly labelled foodstuff products were found belonging to 77 batches (96.3% of products in a batch being incorrectly labelled) and in more than 1/3 (33%) batches consisting of 69 batches (86.3%). In some product batches incorrect labelling exceeded 70% and sometimes even 90%.

Methods of food fraud depend on the specifics of particular foodstuffs and the types of manufacturing technologies involved and their continual advancement and development. Fundamental transgressions, that are typical examples of fraud and which were found during inspections of foodstuffs derived from plants are shown in Tables 1 and 2, whilst those from animals in Tables 3, 4 and 5.

It is estimated that within the EU, the scale of food fraud is around 20% and thus the European Parliament intends to toughen the penalties imposed on those companies allowing such practices.

A need therefore exists for rapid information exchange at the EU level concerning cases of food fraud. At the national level, measures are now being undertaken for making inspections more effective. At the EU level a need therefore exists for rapid information exchange concerning cases of food fraud; special system for monitoring of food fraud to be based on the RASFF system (Rapid Alert System for Food and Feed) [9], which should thereby decrease levels of transgressions and improve the authenticity of food throughout the EU.

CONCLUSIONS

1. The several thousand food inspections analysed over 2005-12 in this study, has demonstrated significant irregularities in foodstuffs present on the Polish market.
2. The fewest transgressions were for organoleptic properties of foodstuffs (1-1.5% of analysed batches). Those for physico-chemical characteristics, were estimated at 15% that slowly but constantly rose to over 17% in 2013, ie. 1:6 batches were found to be fraudulent.
3. The scale of transgressions and fraud were greatest for foodstuff labelling, however in 2011-12 this improved. During 2008-10 levels were at 35% but in 2011-12 they decreased to 27%.
4. Appropriate action is thus required at both national and EU levels over the surveillance and monitoring of food fraud in order to bring about improvements.

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