A study on adulteration in cereals and bakery products from Poland including a review of definitions

by Kowlaska, A., Soon, J.M. and Manning, L.

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Authors

ALEKSANDRA KOWALSKA[1], JAN MEI SOON[2] AND LOUISE MANNING[3]

[1]Department of Quality and Knowledge Management, Faculty of Economics, Maria Curie-Skłodowska University, Lublin, Poland aleksandra.kowalska@umcs.lublin.pl

[2]International Institute of Nutritional Sciences and Applied Food Safety Studies, School of Sport and Wellbeing, University of Central Lancashire, Preston PR1 2HE UK jsoon@uclan.ac.uk

[3]Department of Food Science and Food Supply Chain Management, Harper Adams University, Newport, Shropshire, UK TF10 8NB lmanning@harper-adams.ac.uk

Corresponding author email address: aleksandra.kowalska@umcs.lublin.pl

Abstract

The aim of the study was to critique the food adulteration trends associated with cereals and bakery products from Poland. The methodological approach was to firstly review existing literature to define and outline the challenge of food adulteration and the degree of harmonisation, or not, of definitions, and then to analyse local and European data on the prevalence of food adulteration and mislabelling in the cereals and bakery sector more generally, and specifically in Poland. Analysis of general RASFF notifications of cereal and bakery products linked to Poland (n=177) revealed that most non-compliances were due to mycotoxins, undeclared allergens and undeclared genetically modified materials. Key notable trends included an increase in incorrect allergen labelling with only two incidents directly associated with adulteration firstly with melamine and also suspicion of deliberate contamination of milk powder with rodenticide. Data from IJHARS share similar trends where most reported irregularities associated with cereal and bakery products were related to mislabelling. The definition of adulterated foodstuffs in Poland concentrates on mislabelling particularly regarding product composition rather than being differentiated by the motivation

of the perpetrator. This is not in step with other definitions where intent is seen an inherent aspect of a determination of an instance of food fraud or adulteration. This work demonstrates that even in harmonized regulatory areas such as the EU there are local definitions of adulteration that due to the lack of consistency could influence collective approaches to determining the extent of or addressing the problem of mislabelling, misrepresentation and misbranding as a form of adulteration.

Highlights

- Most commonly reported adulterated cereal and bakery products in Poland were bread and pasta.
- Most cases of food adulteration were related to mislabelling
- More research needed to contextualise drivers for mislabelled and misrepresented products.

Key words: adulteration, mislabelling, motivation, misbranded, bread, misrepresented

Abbreviations non-standard

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1. Introduction

Following the 2013 horsemeat scandal, there has been resurgence in public and business interest in food fraud. Indeed, assuring food authenticity and mitigating adulteration have been major drivers for establishing food regulations worldwide (Kölbener, Bieri & St-Gallen, 2016). Food fraud is defined by the United Kingdom (UK) Food Standards Agency (FSA) as: *"deliberately placing food on the market, for financial gain, with the intention of deceiving the consumer"* (Elliott Review, 2014), although food safety concerns exist (Moore, Spink, & Lipp, 2012). Food fraud includes the subcategory of economically motivated adulteration (EMA) i.e. deception for economic gain using food products, ingredients and packaging including activities such as substitution especially with substandard or inferior products, unapproved additions or enhancements, misbranding or misrepresentation, tampering, counterfeiting, using stolen goods and others (Spink & Moyer, 2011; GFSI, 2014; Manning & Soon, 2014; BRC, 2015; Manning, 2016).

However, there is a lack of harmonisation of definitions and uses of the term "adulteration". The previous definition refers to EMA, but food adulteration can be simply be when a product contains an element or ingredient which is fraudulent (Spink & Moyer, 2011) or else adulteration can be described as the actions that are taken to add or adjust a food item or composite food product by the use of extraneous, substandard, or inferior ingredients (Manning & Soon, 2014). Bansal, Singh, Mangal, et al. (2017) in their work on the problems with adulterated food products in India state that "food adulteration can be defined as lowering the quality of food by intentional or unintentional substitution of food with some inferior foreign particle or by removal of some value added food substitute from main food item". This latter definition contests that both intentional and unintentional actions which can affect quality, and safety may be classed as adulteration. This demonstrates an inconsistency in the way terms

are derived and used when considering food adulteration.

The challenge of food adulteration is complex with multiple factors of influence including market competition, supply chain pressure and power dynamics, resource scarcity, inadequate governance, lack of sanctions and low probability of discovery, rapid development of systems, logistics and technology, data swamping and opacity (Charlebois, Schwab, Henn, & Huck, 2016; Manning, Smith & Soon, 2016; Marvin et al., 2016). Food adulteration has been associated with high value food such as olive oil (Garrido-Delgado, Munoz-Perez & Arce, 2018), honey (Amiry, Esmaiili & Alizadeh, 2017) and herbs and spices (Silvis, van Ruth, van der Fels-Klerx & Luning, 2017; Galvin-King, Haughey & Elliott, 2017). Although luxury items are perceived to be more likely to be targeted by fraudsters, generally they are not eaten in the same quantity as cereal-derived products. Indeed, the very first piece of public health legislation passed in the UK was the 1757 "Act for the due making of Bread; and to regulate the Price and Assize thereof; and to punish Persons who shall adulterate Meal, Flour, or Bread." (Scally, 2013, p. 346). Thus, it can be argued that there is potentially a greater risk of cumulative financial and personal harm from adulterated foods that are eaten and purchased more often and in larger amounts. This forms the research rationale for why cereal-derived products are the focus of this research.

2. Methodology and research rationale

Cereal grains such as wheat and derived flour are major ingredients for the most important staple foods in the EU such as breads, pasta, cakes, and biscuits (Murniece & Straumite, 2014; Cozzolino, 2016; Geng, Harnly, & Chen, 2016). Poland is one of the major cereal producers in the EU and in 2015 exported more than 20% of the total cereal produced (CSO, 2016a) highlighting the risk to illicit activity associated with Polish cereals and bakery products and the impact within Poland and also for other countries. Appropriate prevention

measures can only be implemented if the nature and type of illicit activity is understood (Tähkäpää, Maijala, Korkeala, & Nevas, 2015). Thus, this research aims to determine and analyse the extent of reported food adulteration cases in cereals and baked goods in Poland in order to identify potential trends and frame the development of future empirical research in this area.

Food adulteration cases were analysed at two reporting and control system levels (EU and national levels in Poland) and iterative analysis identified potential patterns of incidence. The EU Rapid Alert System for Food and Feed (RASFF) database was searched using the product category 'cereals and bakery products' and hazard category 'adulteration/fraud', 'labelling absent/incomplete/incorrect', and 'composition'. A further search in RASFF using 'Poland' under the country origin was also conducted. Similarly, we retrieved and analysed all 'Adulterated agri-food items' notified in the Agricultural Food and Quality Inspection (IJHARS) site from 2010 – 2017. A previous study by Kowalczyk (2015) used IJHARS food inspection data to assess the main areas of food fraud, but was not specific to cereals and bakery products, thus making the research described herein of interest. We have structured the paper as follows: Section 1 is an introduction and a brief overview of food adulteration terminology; and Section 2 provides the underlying rationale and the methodology employed. Section 3 synthesizes existing literature and considers secondary data to review cereal production and manufacture of cereal based and bakery products in Poland and the resultant value to the Polish economy. Section 4 provides a brief review of the local (IJHARS) and international (RASFF) databases and reviews the data derived in this research. In Section 5 results are presented and discussed. Section 6 concludes the paper and seeks to identify potential trends and frame the development of future empirical research.

3. Background to the Polish cereal sector

3.1 Agricultural cereal production in Poland and associated exports

Globally, wheat is the most important cereal for bread making, however rye bread has an established place in food culture in Northern and Eastern Europe (Pohjanheimo, Paasovaara, Luomala & Sandell, 2010; Murniece & Straumite, 2014). In 2015, Poland exported 21.8% of its total cereal production, which accounted for 2.7% of Polish GDP. The main export product was wheat and spelt with key export markets being Germany, Egypt, Saudi Arabia, Algeria, and Morocco. The value of Polish cereal products exports (bread, pastry, cakes, biscuits, wafers etc.) accounted for 99.8% of the total value of cereal exports in 2015 (CSO, 2016a). Poland is the third largest cereal producer in the EU-28 after France and Germany. Analysing the structure of utilised agricultural area (UAA) identifies the dominant role of cereals in national production (Czyżewski & Staniszewski, 2016) with Denmark (55%), Poland (52%) and a significantly lower share in Germany (39%) and France (35%) producing the majority of cereal in EU. Common organisation of the cereals market was initiated in the late 60s of the 20th century and EU Member States benefited from intervention buying, storage and sale of cereals through the evolution of the Common Agricultural Policy (CAP). In 2015, the quantities of rye and meslin produced in Poland account for 28.5% of the total EU production of those cereals (Europa, nd). The combined volume of cereal production places Poland second among other EU Member States in terms of output. Moreover, Poland is the largest oats producer contributing 16% of 2015 EU production. In Poland, oats are used in industrial processing e.g. for energy purposes (Kawka & Achremowicz, 2014; Głowacka, Zych & Żołnierczuk, 2016), and are a valuable source of nutrients and multiple bioactive compounds, being used widely in gluten-free products (Pinto-Sánchez et al.; 2017). More recently, spelt is of particular interest in Poland with organic farmers, because of its high nutrient content, lower habitat requirements and impact (Knapowski et al., 2017) and cost-effectiveness of production (Kowalska, 2010).

3.2 The influence of socio-economic changes in Poland on consumption and supply chain structure

The socio-economic transformation of Poland has contributed to qualitative and quantitative changes in the national food consumption. National data from 2003-2015 suggests Poles are eating less, but better food (the caloric content is reducing, while the nutritional value of the average portion size is increasing) and more expensively while eating more frequently outside the home (Świetlik, 2017). Despite consumption systematically decreasing across all socioeconomic groups of the Polish population (Stanisławska & Kurzawa, 2016), bakery and cereal products still hold a key position, as average monthly per capita consumption in Polish households is only second to the consumption of vegetables, including potatoes (CSO, 2016b). Moreover, on the basis of Polish history, culture and prevalent religion, bread is culturally respected within the diet but despite this, bread is one of the most often wasted food in Polish households (Śmiechowska & Chrzanowska, 2015; Kowalska, 2017).

In 2015, there were 154 Polish pasta production plants (CSO, 2016c). Consolidation of the pasta and noodles market has occurred, but national demand is still showing an upward volume trend. Whilst being a leading producer of bread and cereals compared with other EU countries, on the supply side, there were 8543 bakeries and confectioneries in Poland in 2015 (CSO, 2016c). Mostly small local enterprises they hold a relatively weak business position in the context of global supply chains being at a competitive disadvantage with both large-format stores and material suppliers, and as a result the number of small bakeries is continuously decreasing. However, these businesses often have good reputation in the communities in which they operate. Such a difficult commercial situation is not unique in the Polish food industry. Therefore, a law on prevention of unfair use of contract advantage in marketing of agricultural and food products was adopted in 2016 (The Act on the Prevention… 2016). Consideration of these small bakeries shows worse financial performance, but at the same time a higher social and environmental performance when compared with global businesses.

Although adoption was a legal requirement, two years after the accession of Poland to the EU, the level of hazard analysis critical control point (HACCP) system implementation in bakeries, confectionaries and cereal-miller production plants was relatively low being 10-40% of those businesses legally required to implement HACCP (Kowalska, 2010). Generally, small and medium enterprises in Poland had economic difficulties when implementing HACCP (Trafiałek & Kołożyn-Krajewska, 2011). However, by 2015, about 80% of bakeries, confectionaries and cereal-miller production plants were compliant (CSO, 2016c). National data from 2005-2015 demonstrates the sanitary state of these establishments (disqualified samples as a percentage of samples tested), suggesting that sanitary and food hygiene conditions have also improved (CSO 2016c).

The strategic national aim is to build competitive advantage for Polish cereals and bakery on the global market, thus demonstrating consistent, excellent food safety standards, product integrity and authenticity and engendering supply chain and consumer trust underpin this ambition. Effective Polish legislation regarding the issue of food adulteration and also the Polish food control institutions' activities in this area will significantly contribute to ensuring legal compliance. Protecting consumer health and life is a major concern addressed by both EU food law and Member State food control activities as well as mitigating fraudulent, deceptive and other misleading practices that could harm the economic interests of consumers, national GDP and the wider food industry. These are now explored.

4. Databases analysed and derived data

4.1 Agricultural and Food Quality Inspection (IJHARS), Poland

Article 9.1(b) of Regulation EU 2017/625 on official controls and other official activities performed to ensure the application of food and feed law …. of 15th March 2017 states that: Competent authorities shall perform official controls on all operators regularly, on a risk basis and with appropriate frequency, taking account of: .. any information indicating the

likelihood that consumers might be misled, in particular as to the nature, identity, properties, composition, quantity, durability, country of origin or place of provenance, method of manufacture or production of food. Two Polish laws aim to protect the consumer in the food chain:

1. The Act on the Safety of Food and Nutrition (2006) which lays down rules and procedures in order to ensure food and nutrition safety regarding any health implications for consumers, and
2. The Act on Commercial Quality of Agricultural and Food Products (2000) which regulates quality issues and their economic implications for consumers (u.j.h.).

The definitions of fraudulent foodstuffs introduced by the two aforementioned Acts concentrates on mislabelling, mostly regarding product composition. Under Article 3 of the Polish Act on Safety of Food and Nutrition, adulterated foodstuff is determined in these regulations as a foodstuff whose composition or other properties were changed without informing the consumer about it, or a foodstuff changed in order to conceal its intrinsic composition or other properties, and affecting the safety of the foodstuff. Under Article 3 of u.j.h., adulterated agricultural and food product is defined as a product whose composition does not comply with the provisions of regulations regarding commercial quality of individual foodstuffs, or a product changed (including mislabelling) in order to conceal its intrinsic composition or other properties, as long as the mentioned non-compliances or changes significantly violate consumer interests. Herein the term adulterated focuses on the inherent, intrinsic state of the food rather than the motivation of the perpetrator, which differs from the definitions outlined in the introduction. This lack of harmonisation is a very important point because in Poland, the business operator that produces or places adulterated food on the market, carries administrative, criminal and/or civil liability for the action (The Act on Commercial

223 Quality… 2000; The Act on the Safety of Food… 2006), irrespective of there being an intent
224 to mislead.

225 The Agricultural and Food Quality Inspection (IJHARS) in Poland takes both control
226 and preventive actions for issues that could affect consumers' safety and food authenticity along
227 the whole food supply chain, excluding retail trade (in the hands of Trade Inspection, IH). The
228 provincial inspector of IJHARS is entitled to issue administrative decisions concerning: a)
229 prohibiting the marketing of adulterated product, reprocessing or discarding adulterated
230 product, etc., (Article 29 paragraph 1 u.j.h).; and b) imposing a financial penalty on the operator
231 that places adulterated food on the market (Article 40a u.j.h.). Both IJHARS and IH conduct
232 border inspections of exported/imported agri-food products. The IJHARS publishes
233 administrative decisions associated with food adulteration on-line including: number and date
234 of the decision regarding detected food adulteration, legal basis of the decision, the name of a
235 particular product concerned, the number of production batch and the date of production, batch
236 volume, confirmed irregularities, and the name of an entity that places the food on the market.
237 The public is not informed about the details of actions undertaken in relation to food
238 adulteration detection. Further, the information (intelligence) and its source are not generally
239 known.

240 **4.2 Rapid Alert System for Food and Feed (RASFF)**

241 The EU RASFF database is a centralised platform developed to ensure the safety of
242 food and animal feed in the EU. Members, including the EC, EU members, European Food
243 Safety Authority (EFSA), European Free Trade Association [EFTA] Surveillance Authority,
244 (i.e. Iceland, Liechtenstein and Norway) and Switzerland, are obliged to notify and to exchange
245 information on food safety issues and measures (RASFF, 2017). The RASFF database provides
246 members with a tool for exchanging information about measures taken in response to serious
247 risks detected in relation to food and feed both internally within the country and at border

248 inspection points (Tähkäpää et al., 2015). An alert is the highest level of notification to inform
249 member countries that the food, feed or food contact material present a serious risk on the
250 market and rapid action is or might be required (RASFF, 2017). The six food fraud categories
251 in the EU RASFF database are: improper, fraudulent, missing or absent health certificate; illegal
252 or unauthorised import, trade or transit; adulteration, fraud or tampering; improper, expired,
253 fraudulent or missing common entry document (CED), import declaration, or analytical report;
254 expiration date; and mislabelling (Bouzembrak & Marvin, 2015). Within the hazard category
255 'labelling absent/incomplete or incorrect' categories include: insufficient labelling such as
256 absence of allergen declaration, incorrect labelling e.g. incorrect or absent declaration of gluten
257 free status. The RASFF (2017) composition category includes categories such as unauthorised
258 presence of colours or other materials, or excess content of vitamins, metals (such as
259 aluminium).

260 Multiple studies have analysed RASFF data for incident frequency and trends (Kleter,
261 Prandini, Filippi, & Marvin, 2009; Tähkäpää et al., 2015; Bouzembrak & Marvin, 2015; Marvin
262 et al., 2016; Djekic, Jankovic & Rajkovic, 2017). Analysis of RASFF data has focused on
263 microbiological and chemical hazards rather than physical hazards and of the foreign body
264 notifications analysed in their study for Eastern Europe (n=411), 93% were attributed to pest
265 contamination (Djekic et al,. 2017). This work classified Eastern Europe as Bulgaria, Czech
266 Republic, Hungary, Poland, Romania and Slovakia and across Europe as a whole, bakery
267 products were in the top three categories of products most likely to be contaminated with
268 foreign bodies.

269 With regard to fraud specifically, Tähkäpää et al. (2015) compared both RASFF fraud
270 notifications and local Finnish fraud notifications. In order to develop a food fraud risk
271 assessment tool, Marvin et al. (2016) developed a set of variables over and above food fraud
272 type including **economic factors** (e.g. price, supply and demand); **national factors** associated

with the country of origin (e.g. governance) and **specific incident related factors** such as fraud type, complexity and the potential for fraud detection. The two variables identified by Marvin et al. (2016) with the greatest influence on the type of food fraud committed were country of origin and product. However, care should be taken with simple arithmetic analysis of incidents in RASFF as one incident can skew the frequency of notifications. For example in 2017, fipronil use on egg farms resulted in multiple notifications in RASFF (115 notifications at the time of writing). This creates a challenge when trying to objectively quantify particular types of incidents using RASFF data alone (Bouzembrak & Marvin, 2016). The potential for a different system of categorisation of incidents between member state databases and RASFF, either by design or by individual inspector discretion, also needs to be considered when drawing comparisons between the two levels of system.

4.3 Food fraud associated with cereals and bakery products

The development of fraudulent practices in the food industry is mediated by supply and demand dynamics, trends and current consumption models and any given dietary recommendations. There are multiple examples of authenticity concerns associated with cereals (Pegels, González, García, & Martín, 2015); and RASFF notifications for bakery (Tähkäpää et al., 2015). Bakery products are characterised by a restricted shelf life, heterogeneity of ingredients, and seasonal variability in product quality due to production and harvesting conditions (Van der Spiegel, Luning, De Boer, Ziggers and Jongen, 2005) whereas dehydrated pasta products have a long shelf life. Adulteration may be motivated not only to mislead or for economic gain, but also to meet stated customer (retailer or food service) requirements. European legislation states that durum wheat pasta can contain a maximum of 3% of common wheat, so this standard itself may actually incentivise the substitution in the pasta supply chain meeting minimum specifications and deriving best economic return, especially where durum wheat is 25% more expensive than common wheat (Knödler, Most, Schieber, & Carle, 2010;

Righetti et al., 2018). Contemporary examples of tainted baked goods include steamed buns in China produced using yellow coloring and sodium cyclamate, an artificial sweetener banned in the United States of America (USA) see China.org.cn (2011) or steamed 'corn buns' sold without corn, but containing flavouring and artificial colours (Everstine, Spink & Kennedy, 2013) and using dried bakery waste was associated with dioxin contamination in food and feed (Hoogenboom et al., 2004) Thus, there is literature context for malpractice in the cereals supply chain.

5. Results and discussion

5.1 RASFF Database

The product category cereals and bakery products on the RASFF database was searched for notifications linked to the hazard category **adulteration/fraud**. There were 42 notifications between 2004 and January 2018, the majority being border rejections (n=32) with information notifications (n=8) and alerts (n=2). The non-compliances raised were absence of certified analysis report (n=27), illegal or unauthorised import (n=6), fraudulent health certificate (n=4), improper health certificate (n=2); expiry date change (n=2) and tampering (n=1) with 83% of the products coming from China or Hong Kong and none linked to Poland. Analysis of incidence by product includes that 83% of the products were rice, rice products or noodles, with frozen pastry or pies (n=3) and biscuits/cookies (n=2) and cake/cake mix (n=1).

There were 149 notifications for the hazard category **composition** between 1996 and Jan 2018, with border rejections (n=76), information notifications (n=35) and alerts (n=38). Three further notifications arose as a result of companies' own checks and additional two following customer complaints. The non-compliances raised were high content of aluminium (n=116) mainly associated with noodles and rice products from China, Hong Kong and Vietnam and unauthorised colours including Sudan 1 and Rhodamine B (n=27). Analysis of incidence by product highlights that 74% were rice, rice products or noodles, pasta (n=22),

bread/breadcrumbs or flour (n=7), cake/cake mix (n=3), biscuits/cookies (n=3), and frozen pastry or pies (n=1) and three other notifications were for spelt/cereal (n=1) and one for multiple products. There were five incidents associated with Poland.

There were 21 notifications for bakery and cereals products in the hazard category **labelling absent/ incomplete/ incorrect** between 1996 and Jan 2018, with border rejections (n=3), information notifications (n=14) and alerts (n=4). Insufficient labelling notifications included lack of allergen declaration (n=13); incorrect labelling e.g. gluten free declarations (n=6) and absence of labelling (n=2). Six notifications were associated with Poland (29%) compared with 10% from China/Hong Kong (n=2). Analysis of incidence by product highlights that whilst 24% of the products were rice, rice products or noodles, pasta (n=5), biscuits/cookies (n=8) showed the highest incidence of non-compliance, with cake/cake mix (n=3), muesli (n=2), bread/breadcrumbs or flour (n=1), spelt/cereal (n=1) and one more notification for multiple products.

There were 177 notifications for cereal and bakery products associated with Poland between 2004 and January 2018 either because the products may have been notified to RASFF by Poland itself or there was the potential for distribution within Poland. These notifications included both those in the hazard categories already described and other hazard categories within the RASFF database. By notification type, alert was the largest group (n=92), information (n=62) and border rejection (n=21). The notifications were by official controls (n=105), border control rejections (n=29), companies' own checks (n=24), customer complaint (n=18) and food poisoning (n=1). The non-compliances raised with the highest frequency were mycotoxins (n=47), undeclared allergens (n=24), undeclared genetically modified material (n=19), pests generally insects and physical contamination from mice (n=13), mould contamination (n=12) and problems with gluten declarations (n=11), organoleptic issues (n=9), metal contamination (n=7), high content of aluminium (n=5), glass contamination (n=5) and

glycol (n=5), other issues (collectively 30 notifications) had a lower frequency of occurrence. Upon further analysis, there is a potential adulteration incident in 2008 where 3.5 ppm of melamine was found in salty sticks from Poland (RASFF, 2008). This incident coincides with the Chinese melamine contamination of multiple product categories (Gossner et al., 2009). Salty sticks are wheat based Polish snacks and it is speculated that wheat flour used was tainted with melamine. The risk decision was undecided at that time as the adulteration and recall of tainted food from China was beginning to occur. A second incident detected from the analysis was the suspicion of rodenticide granules found in milk powder used to make waffles that were recalled from consumers and were categorised as serious risk although nothing further is reported. Analysis of incidence by product highlights that 26% of the products were rice, rice products or noodles, pasta (n=46), bread/breadcrumbs or flour (n=34), biscuits/cookies (n=18), cake/cake mix (n=8), linseed (linked to a specific incident n=8) and pasta products (n=8). All other incidents were across a range of products all with lower incidence.

Analysis of the RASFF database allows for identification of bakery products of interest and potential non-compliance that can be compared with the data from Poland. There are notable trends in the data, for example the rise in recent years for notification of incorrect allergen labelling or problems with appropriate labelling of gluten free products perhaps as a result of changes in EU Food Information for Consumers (FIC) Regulations that came into force in 2014, problems with health certification and in two cases a change of expiry date. Other issues that have been identified were undeclared genetically modified material, which is not currently categorised under food fraud/adulteration in the RASFF database.

5.2 IJHARS Data

There are 427 administrative decisions publicised on the IJHARS webpage regarding adulterated agri-food items from 2013-2017. It is common that one decision covers several adulterated agri-food items from the same producer, and there are also instances of repeat

offence by a specific producer. Most non-compliances occur in the following product categories: meat and meat products, flour, cereal and bakery products, delicatessen (ready to serve) products (Figure 1). Other food categories contain 1 to 6 adulteration cases (e.g. food concentrates, non-alcoholic beverages, spices, chocolate products).

Take in Figure 1

Issues of adulteration of meat/meat products is typical of EU incident datasets that were skewed directly by the 2013 Horsemeat Scandal and analysis of the data presented in the 2016 annual report of the EU Food Fraud Network and the System for Administrative Assistance & Food Fraud (AAC FF) shows that the most food fraud cases exchanged in the AAC FF concern meat and meat products (26.7% of all 176 food fraud cases identified). Cereal and bakery products are the second most frequently identified products for food fraud/adulteration in Poland underpinning the rationale to focus on these products. Publicly available IJHARS administrative decisions from the years 2010-2017, comprising 209 adulterated cereal and bakery products marketed by 108 operators were analysed in this study. The large majority of items (94.7% of all cases) were flour and cereal products (including bread, pasta, baking flour and breadcrumbs), and only 11 agri-food items belonged to the category of pastry, cakes, biscuits and other bakers' wares (including biscuits and waffles). The most commonly reported adulterated cereal and bakery products in Poland were bread and pasta (Figure 2) and in most cases the problem related specifically to mislabelling.

Take in Figure 2

Mislabelling of this nature could be intentional or unintentional and due simply to human error, lack of verification during product / labelling change in production system or even an error in original artwork design. Other products where non-compliance occurred include corn crunchies, semolina, barley, buckwheat, muesli, matzah, bakery products different than bread

397 ('small pizza'), sponge cakes, cupcakes, spit cake, puff pastry, and each one of these was
398 notified only once. IJHARS detected food fraud/ adulteration in the category of cereal and
399 bakery products in each of the 16 provinces in Poland, but most irregularities were identified
400 in West Pomeranian, Kuyavian-Pomeranian and Lubusz Province. The main irregularities in
401 adulterated bread and pasta detected by IJHARS in 2010-2017, from the most to the least
402 frequent, are described in Table 1 and Table 2.

403 **Take in Tables 1 and 2**

404 The results of IJHARS inspections of cereal and bakery production in 2010-2017 reveal
405 that 98% of adulterated products were mislabelled. Physicochemical parameters of 18% of the
406 products were also incompatible with producer's declaration. IJHARS did not identify any
407 problem with organoleptic properties of controlled cereal and bakery products. The most
408 common violations were:

409 • **mislabelling: composition** – missing items in the list of ingredients, declaration of
410 ingredients not used in the production process,

411 • **mislabelling: misnomer** – incorrect/ incomplete/ no (descriptive) name of the product,
412 and

413 • **mislabelling: method of production** – unfounded claim 'no bread improvers', 'no
414 preservatives', 'no chemical additives', 'rustic', 'home', 'traditional recipe', etc.

415 In Poland, mislabelling is a bigger problem than organoleptic and/or physicochemical non-
416 compliance with a producer's label declaration or specification. The types of mislabelling have
417 been differentiated by product (bread and pasta) and show that composition is the major area
418 of non-compliance with bread whereas method of production was the main area of non-
419 compliance with pasta (Figure 3).

Take in Figure 3

In 2016, every fifth production batch assessed by IJHARS was incorrectly labelled (see www.ijhar-s.gov.pl) and with plant-based food products, bread and bakery products were the most frequently mislabelled (Kowalczyk, 2016).

5.3 Summary

Analysis of the RASFF and IJHARS databases highlights some challenges when seeking to compare and quantify the incidence of food adulteration. Commercial quality evaluation undertaken by IJHARS is based on three food quality attributes: organoleptic features, physicochemical characteristics and labelling. All mislabelling cases detected by IJHARS are treated as adulteration, but this is not the case with the RASFF system making comparison difficult. The administrative liability of the operator that places adulterated food on the market in Poland is objective (non-judgmental) and the only condition for imposing a sanction is the fact of placing such food on the market. The sanction is determined irrespective of guilt i.e. both intentional and unintentional action are considered as adulteration (Supreme Administrative Court, 2013).

It is important to consider whether the data that has been analysed here reflects the actual level of adulteration in Poland or whether the non-compliance frequency is skewed by risk-based purposive sampling by the IJHARS as is required by legislation such as EU Regulation 2017/625. Therefore it is difficult to determine if mislabelling of cereals and bakery products is becoming a more frequent problem in Poland as the number of inspections that were carried out by IJHARS varied over the time period analysed. There were 7 519 – 9 000 IJHARS inspections carried out on the domestic market in 2010 - 2013, 11 675 inspections in 2014, 12 220 inspections in 2015, and 35 169 inspections in 2016 i.e. there were four times as many inspections in 2016 than in 2010. On the other hand, the number of IJHARS inspections at

import and export stage decreased from 80 - 90 000 in 2010-2014 to 60 000 in 2015-2016. There have been additional 3 - 4 000 IJHARS inspections carried out annually on request of institutions cooperating with IJHARS (see http://www.ijhar-s.gov.pl) and the areas that IJHARS covers by their planned inspections depended as previously described on purposive risk-based analysis and the input of businesses they inspect.

The differences between food fraud/adulteration information published in the RASFF database and the data regarding the decisions made by IJHARS arises from the essence of the systems themselves. IJHARS carries out planned and ad hoc inspections on both the domestic Polish market and at import and export stages. These inspections are particularly concerned with the marketing quality of commonly consumed products dairy products, meat, fish, cereals, processed fruit and vegetables, ready-to-cook food, honey, eggs, and fresh fruit and vegetables (see http://www.ijhar-s.gov.pl). There is some equivalent in EU member state in terms of domestic databases such as the UK Food Surveillance System (UKFSS), see FSA (2018) or the Finnish Food Safety Authority EVIRA system (Tähkäpää et al., 2015). However the data within the RASFF database is in part driven by different regulatory criteria i.e. purposive risk-based import sampling of specific countries and products. Further the dataset within the RASFF system for adulteration is relatively small so a few incidents can quickly change the overall metrics that are derived and the categories used within RASFF are very broad and worthy of redefinition to aid better isolation of incidents and trend analysis. Where categories are not aligned within national databases and the RASFF this means it is difficult to analyse the combined data for trends and emerging risk without undertaking an in-depth assessment of the multiple datasets.

What are the key factors that can be drawn out here from the analysis of the IJHARS system? Bread, an integral part of the Polish diet, represents over 67% of the reported cereal and bakery incidents on the IJHARS database. The main irregularities highlighted were missing

items in the ingredients list, a lack of, or incorrect description of, the type of flour used; misleading or no information at all on the percentage of some ingredients e.g. sunflower seeds, and unfounded claims on the method of production. These findings undermine confidence in the integrity of bakery products in Poland.

Further it is important to consider the definition of adulteration is actually of value here. Article 3 of the Polish Act on Safety of Food and Nutrition, states an adulterated foodstuff is one whose composition or other properties are changed without informing the consumer about it, or a foodstuff changed in order to conceal its intrinsic composition or other properties, and affecting the safety of the foodstuff. Global Food Safety Initiative (GFSI) Position Statement on mitigating the public health risk of food fraud (July 2014) identifies both intentional adulteration and unintentional/accidental adulteration whereas other sources state that for adulteration to be considered as a subset of food fraud it can only be determined as being intentional (Elliott Review, 2014). This lack of harmonisation of definitions proves challenging. The health implications of food adulteration are complex too. If it is an allergen that is used as an adulterant and then undeclared on labelling this obviously will have health implications e.g. the use of peanut powder in almond powder as an a cheaper "filler". The multiple materials that could be used to adulterate combined with the often lack of immediate, valid data on their health impact when discovered e.g. melamine in wheat gluten means that any investigations are reactive in nature and thus response at regulatory and market level can appear slow to consumers. The economic consequences are implicit in food adulteration. In a given food supply chain there are normative, coercive and mimetic (economic) pressures from respectively lobby groups, consumer, criminal groups, coercive and political pressures from government, buyers and sellers etc. (Kilbourne, Beckmann & Thelen, 2002), and mimetic pressures which emerge from horizontal competition (Zhu, Sarkis & Geng, 2005; Aerts, Cormier, & Magnan, 2006; Sarkis, Gonzalez-Torre & Adenso-Diaz, 2010) that operate at individual levels primary,

secondary, tertiary production and also at the interfaces between levels. Mimetic pressure can be specifically exerted where there is an asymmetry in supply chain power between two or more actors/stakeholders creating vulnerabilities where the potential for adulteration can occur giving rise to illicit behaviour. There is limited independent data on the economic impact of food adulteration and much of that is contained within wider estimates of food fraud e.g. European Epson activities or estimations are based on extrapolation of data from studies to the wider supply chain which are limited as a result because of the embedded generalisations used. Ultimately, placing adulterated food on the market is an action of unfair practice that promotes the competitiveness of the perpetrator whilst undermining the competitiveness of other operators within the sector.

6. Conclusion

Cereal products especially bread and baked goods are an important part of the Polish economy especially for local producers and manufacturers underpinned by effective food safety and product standards management systems and controls. As Poland is one of the top producers and exporters of cereal products in the EU, there is further potential for marketing and exporting a variety of Polish origin bakery products. IJHARS carries out comprehensive inspections of goods locally and at import/export interfaces. As the food chain becomes more global, it is crucial that IJHARS remains vigilant in ensuring the safety and legality of food products especially as has been highlighted in this paper with regard to product labelling. The official controls in Poland are also supported by the EU RASFF system that focuses on the entry and exit of safe and legal food into and across the European market.

This paper has focused on definitions and interpretation of the term adulteration especially in the Polish context. Food can be placed on the market whereby its associated labelling is misleading either inadvertently or intentionally and this has been a challenge highlighted in this paper. Unintentional adulteration can occur as the result of a lack of

knowledge, facilities or resources. The definition of adulterated foodstuffs in Poland concentrates on mislabelling particularly regarding product composition rather than being differentiated by the motivation of the perpetrator e.g. that an individual undertakes adulteration for financial gain (EMA) or to overcome a challenge between the demand for a finished product and the ability to access sufficient ingredients of the correct provenance. This study demonstrates that even in harmonized regulatory areas such as the EU there are local legal definitions of adulteration and these may, or may not, concur with definitions of adulteration in private market standards. A lack of consistency and commonality in definitions could influence collective approaches to determining the extent of or addressing the problem of mislabelling, misrepresentation and misbranding as forms of adulteration at national level and across national border trading such as in the EU. This research shows that more empirical work needs to be undertaken to contextualise the drivers for misbranding, mislabelling and misrepresentation in the food supply chain and for this problem to be seen not just as a subset of food fraud (see Spink and Moyer, 2011), but as a problem worthy of study in its own right. Empirical work needs to place particular attention on how data has been collected within existing regulatory and private databases and the constraints this then places on generalising the results of study work on a range of products and contexts. Research on labelling integrity should be multidisciplinary and focus on food labelling from both a legal and ethical perspective.

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719 **Table 1. Main irregularities detected by IJHARS in adulterated bread (2010-2017)**

Bread (139 cases) Type of irregularity	No of cases	Share of the bread cases
Missing items in the list of ingredients, i.e. bread improver, constituents of a compound ingredient (usually bread improver), ascorbic acid, food additives approved for use, anti-mould substance).	67	48.2%
A lack off, or incorrect description of bread type e.g. type of flour used, e.g. mixed, wheat or rye	44	31.7%
Storage conditions and durability - no information about 'use-by date'/storage conditions	16	11.5%
Method of production – unfounded claim ‘no bread improvers’, ‘no preservatives’, ‘no chemical additives’, ‘rustic’, ‘home’, ‘traditional recipe’, etc.	14	10.1%
Declaration of ingredients not used in the production process	13	9.4%
No reference to allergens e.g. wheat gluten, barley malt, soy flour, sesame seeds	12	8.6%
No/misleading information about content percentage of an ingredient, e.g. wholemeal flower, sunflower seeds, soybeans	11	7.9%
Understatement of net weight	9	6.5%

720 **Source: Own elaboration based on http://www.ijhar-s.gov.pl.**

721 **Table 2. Main irregularities detected by IJHARS in adulterated pasta (2010-2017)**

Pasta (34 cases) Type of irregularity	No of cases	Share of the pasta cases
Underestimation of eggs content	17	50.0%
Underestimation of fat content	8	23.5%
Lack of term "with turmeric spices" in the name of a product	7	20.6%
Missing items in ingredients list	6	17.6%
Method of production, e.g. unfounded claim "home"	5	14.7%
Declaration of ingredients not used in the production process	4	11.8%

722 **Source: Own elaboration based on http://www.ijhar-s.gov.pl.**

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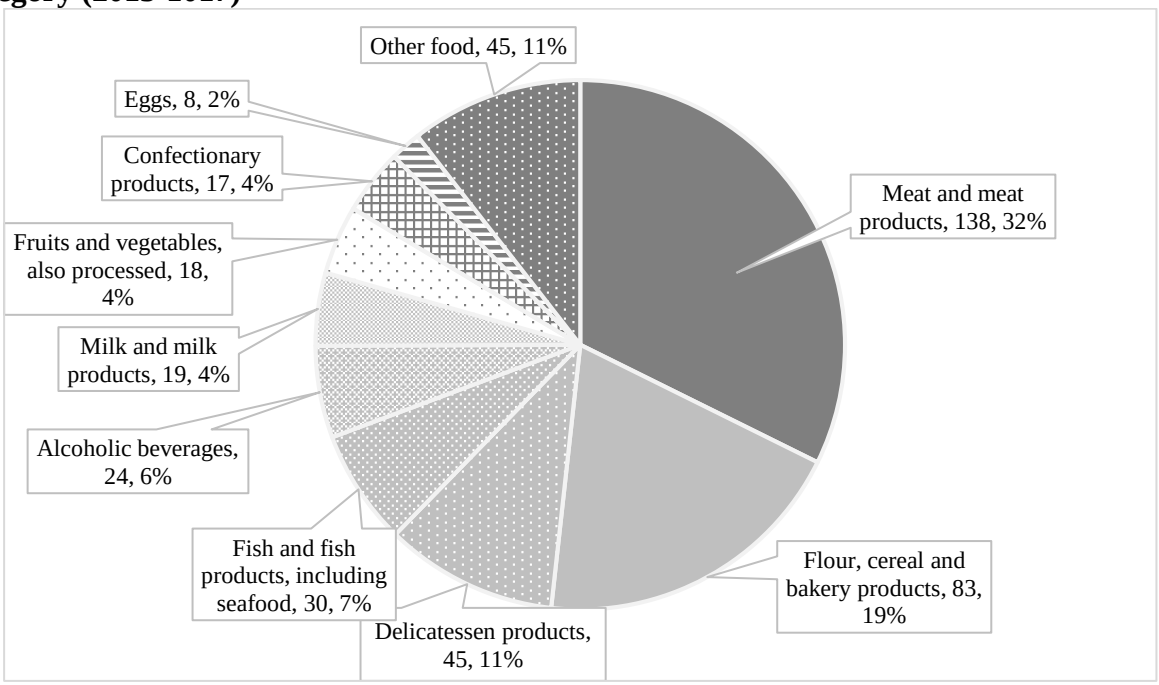
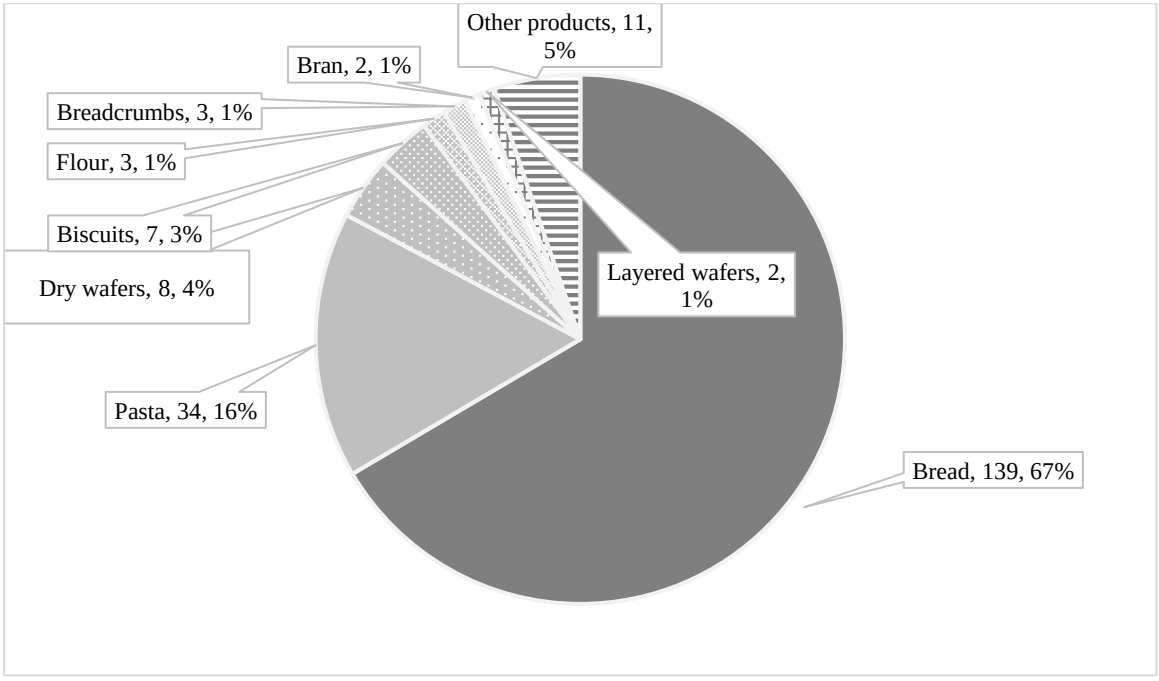
Figure 1. IJHARS administrative decisions concerning adulteration per product category (2013-1017)



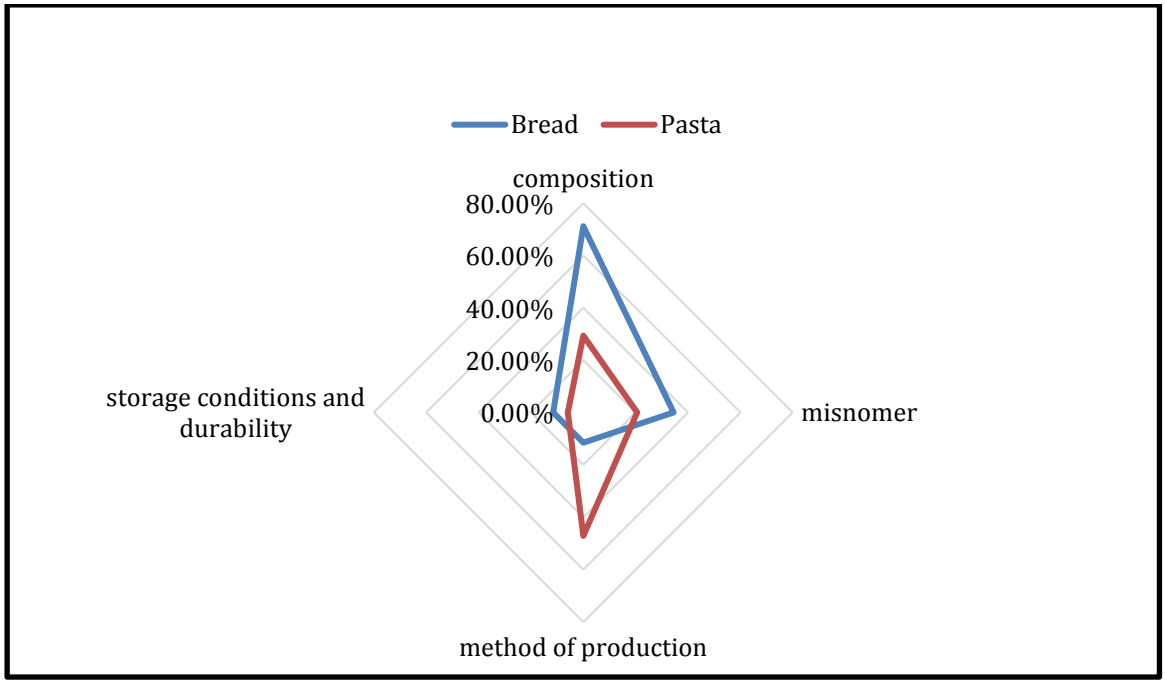
Source: Own elaboration based on http://www.ijhar-s.gov.pl

Figure 2. Reported types of cereal and bakery products in Poland in 2010-2017 within IJHARS administrative decisions concerning adulterated agri-food items



Source: Own elaboration based on http://www.ijhar-s.gov.pl.

734 **Figure 3. The percentage of the main mislabelling irregularities in adulterated bread**
735 **and pasta (2010-2017)**



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737 **Source: Own elaboration based on http://www.ijhar-s.gov.pl.**

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