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Bio-sketch and Photo Page



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Production and supply chain induced health risks in the fruit juice industry

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1 Introduction

From December 2013 to January 2014 Interpol and Europol ran the pan-European operation OPSON III¹. During the operation 5,661 tons of forged food items and 684,000 litres of forged beverages were seized in 31 countries across Europe.

Such spectacular operations and recent public scandals concerning meat supply and processing raise questions about food safety and impact on consumer health. It remains hard to estimate either the impact these goods might have had on the consumer or on the industry. Further it remains hard to find reliable data to which extend deliberate forgery or unintended mismanagement contributed to these incidents in the food and beverage industry.

However, examples like the European horsemeat scandal of 2013² or the OPSON operations show that there are significant risks to consumers and producers in the twenty first century food supply chain.

1.1 The global fruit market

In 2012 the global market for fruit was estimated to be US\$ 456 billion, with china being by far the biggest producer and one of the major exporters³. The fruit trade is characterised by highly globalised supply networks. Especially in developed markets the permanent availability of local fruit and fruit from all over the world has become a standard.

While in Western Europe most fruit is sold to the consumer via retail supermarkets, a new trend is emerging: online purchase and home delivery⁴. While established retailers like Tesco and Carrefour offer online purchase in addition to their supermarkets, companies like Ocado (UK) or Shopwings (Australia and Germany) omit the physical sales place completely.

Another trend which has recently influenced the fruit retail industry is the rising sales of frozen fruit. Convenient to store and mostly ready to eat, frozen fruit has profited from the growing popularity of smoothies⁵.

1.2 The soft drink market

The global demand for fruit juices in 2013 accounted for a US\$ 150 billion market, or in volume measures 64,000 million litres. Only carbonated drinks (2015 million litres) and bottled water (290 million litres)⁶ surpassed the demand for fruit juices in the soft drink industry. With 80%, the off trade consumption accounts for the larger share of the soft drink market.

While the overall soft drink consumption in Western Europe has grown a moderate 5% for the last decade, the consumption of juices declined by about the same amount. Health and wellness

¹ (Europol, 2014)

² (EBSCOhost, 2014, pp. 30-21)

³ (Euromonitor International, 2011)

⁴ (Passport, July 2014, p. 23)

⁵ (Nassauer, 2015)

⁶ (Passport, September 2014, p. 3ff)

positioned beverages of some kind (including sugar reduced drinks and 100% juices) account for 70% of the Western European soft drinks market and a trend towards healthier but more expensive products has supported overall sales.

1.3 Trends in the fruit juice industry

In Western Europe, the segment of ‘not from concentrate’ products has seen an increase parallel to the rising popularity of health and wellness oriented drinks⁷. Consequently, all natural or 100% juices achieve the highest per litre price^{8,9}. As consumers like to see their valuable and healthy drinks, small plastic packaging is becoming increasingly popular¹⁰. Refrigerated single serve juices are pushing back on the consumption of shelf stable juices.

In search for healthy product ideas, juice and tea combinations have seen a rise in sales and flowers have been tested on the market as an ingredient to juices and flavoured water¹¹. Health concerns have led to the limitation of the use of synthetic colorants and new natural products have become substitutes in place¹².

2 Management of health risks in the fruit juice industry

Generically there are four main sources of health risks in fruit and fruit juice production:

- Physically contaminated products – e.g. pieces of glass
- Chemically contaminated products – e.g. high levels of pesticide, unhealthy colourants
- Biologically contaminated products– e.g. bacteria, viruses, fungi and parasites
- Unhealthy diet – e.g. unknown or knowingly accepted consumption of unhealthy products

2.1 Production in the European juice industry

Though smoothies are on the rise, they still represent only a very small part of overall fruit juice volumes. In general, direct or 100% juices account for 30% of the European juice market while 70% are derived from concentrates¹³.

For 100% juices the liquid contents are extracted from the fruit and without further processing the juice is, mostly by tank trucks, forwarded to a production facility. The forwarding has to stick to tight timeframes in order to prevent the juices from spoiling. At the production facilities, each shipment is tested and the delivery specific certificates of the originator and forwarder are checked, as required by the legislation. The juice production generally involves further quality testing and the pasteurisation of the liquids. When bottling the product, it is common practice to test bottles at the beginning, middle and end of a production batch. Some brands require additional testing.

⁷ (Passport, April 2014, p. 19)

⁸ (Passport, April 2014, p. 33)

⁹ (Lee, 2015)

¹⁰ (Passport, September 2014, p. 31)

¹¹ (Boyle, 2014)

¹² (Fuhrman, 2009)

¹³ (Passport, April 2014)

Juices from concentrates are produced in similar patterns. A major difference is that after the liquid extraction from fruits the liquids are partly dehydrated. The resulting low level of chemically available water in the juice after the dehydration causes the concentrate to be biologically much more stable than direct juices. These concentrates can easily be forwarded or stored for extended periods of time¹⁴.

2.2 Risks in the supply and production chain

During fruit production

The establishment of large monocultures of fruit has been supported by the use of pesticides to keep fungi, bacteria and insects harmful to production at bay. These substances cannot be proven to be harmless to humans when consumed. In fact some have been proven to have adverse health effects. As a result, in the EU there are legal levels for residual pesticides on traded fruit and in fruit juices. Also, growing demand for organic fruit and all natural juices in Western Europe requires fruit producers to use less of these pesticides and juice producers to control their supplies more thoroughly. However, fruit retailers and fruit juice producers risk to be supplied with products that do not match the legal requirements or the legal limits.

Apart from the risk resulting from the use of potentially harmful chemicals in the production, there is the risk of biological contamination of the fruit or the liquids extracted from them. Fungi, Bacteria and viruses may be contained within or on the fruit and subsequently make their way towards the consumer.

During fruit transportation and retail

Transportation, intermediate storage and retail expose fruit to a variety of contamination risks. Contact to humans and animals risks the introduction of fungi, bacteria and viruses. While refrigeration may prevent the fruit from damage, it does not protect the consumer.

The trend to smaller PET containers for fruit juices also brings a growing risk of contamination with plasticizers while the juices are presented in retail. The smaller the packaging the higher the content to package-surface ratio. Thus the percentage of juice in contact with plastic packaging is higher in a small bottle. However, the scientific debate about the influence of plasticizers is still ongoing.

The use of frozen and ready to use fruit in smoothies presents a problem of its own. The fruit is presented to the consumer as ready to use, implying there is no need to wash the fruit before consumption. Unfortunately freezing does not rid the fruit of potential pathogenes attached to it. Nor does it inhibit those from causing damage¹⁵.

During juice production

When juice is produced from fruit most of the fruit's nutrients will be transferred to the liquid. The walls of the cells which normally form a physical barrier to stop foreign organisms from feeding on those nutrients get left behind, though. Consequently juice is not only a tasty and nutritious beverage for humans, but also an ideal breeding ground for all sorts of pathogenes.

¹⁴ (Töpfer, 2015)

¹⁵ (Sampson, 2015)

Apart from potentially harmful biological processes in the juice there is the risk of contamination with substances used in the production environment. For example detergents which are used to clean production equipment or oils used in pumps and stirrers. Occasionally due to machine faults or spills, other substances like oil or solids might accidentally make it into the juice production.

2.3 Risks and their potential consequences

Scandal contagion

For retail and producer brands alike the risk of scandal contagion¹⁶ can be considered the one that is the hardest to manage. While every company can improve and control upon its own processes using its quality management and internal audits, there is a limit to how much it can control its suppliers. Apart from occasional supplier audits, there will be a level of trust in the supplier and trust will connect one link of the supply chain to the next. If one link in the supply chain gets involved in a scandal, it will most likely affect all other links downstream towards the consumer. Companies selling recognisable consumer brands can suffer massively from this kind of reputational loss.

Bad online reviews

Apart from scandals which cause public outcry, there is the growing importance of online reviews¹⁷. These are typically done by single consumers without any scientific backup, but if they grab the attention of the public domain, they can become quite harmful. An angry letter by a disappointed customer is no longer settled by a voucher for a future purchase, but may have the potential to become threat to a company's reputation.

Rising consumer expectations

With the demand for healthy food and juices rises the quality expectation of the customer. 100% juices and organic products are sold at a premium price and the customer expects a premium product. Deviation from the expected quality is likely to cause significant damage, if not irreversible damage.

Long term health threats

A risk that producers of juices and especially of 100% juices should keep in sight is that the high levels of sugar in all natural juices may be linked to diabetes. On top of that, research shows that high caloric juices may saturate children's energy intake and consequently the juices may substitute other necessary nutrition¹⁸ resulting in an unhealthy diet.

Additional ingredients

Last but not least, colours are an essential part of food and drink consumption and producers will continue to push for intensive colourants. Natural colours have proven to be less stable than synthetic dyes. Encapsulation is an emerging nanotechnology in which natural pigments

¹⁶ (Passport, February 2014, p. 35)

¹⁷ (Passport, July 2014, p. 30ff)

¹⁸ (Wojcicki & Heyman, 2012)

are encapsulated in order to be protected from degradation. But the encapsulation itself may have adverse health effects.

Experimental ingredients like flowers or herbs can become a distinguishing factor for a beverage, but they also bring additional risks to the supply chain and to the concept of the beverage itself.

2.4 Risk management by the EU and the state of Germany

Within the EU the control mechanisms for health risks in the food and beverage industry have been streamlined. As the largest market for consumer goods in the EU, Germany is a suitable representation of the governmental control systems in place.

While the regulatory framework and product specific chemical and biological limits are defined by the EU or the national states, the responsibility to provide only food within these limits as well as the liability for the infringement of these limits lies with the producers and suppliers¹⁹.

The Federal Office of Consumer Protection and Food Safety (BVL) coordinates the supervision of the private quality control mechanisms within the food industry. As part of this coordination the federal states maintain offices and laboratories which actively control the food supply and production within the state. Checks are administered on all goods sold and produced within the state. In addition to random checks the office conducts targeted tests on product and industry groups according to recent findings.

As local production facilities are legally liable for adverse health effects of their products, they often voluntarily ask the BVL to assess their products. As a result the producers can evaluate the quality of their own testing²⁰.

Each production facility is required to have a HACCP Concept (Hazard Analyses Critical Control Point) in place. HACCP is a preventive safety system that helps companies prevent food contamination by defining potential hazards and control points in the production system. At these control points the product is tested for contaminants, and in case of findings the production can be stopped.

3 Conclusions

3.1 Systemic shortcomings

The system put in place by the EU holds the producers liable for harm done to the consumers. However, it has been proven time-consuming and costly to actually prove liabilities and penalize accordingly.

A prominent example of how difficult it can be to even find the source is the E.coli scandal of 2011^{21,22}. While an increasing number of people suffered from severe infections it took the responsible authorities one month to locate the source of the bacteria. Under public pressure the

¹⁹ (BVL, 2015)

²⁰ (Jungfer, 2015)

²¹ (BBC, 2011)

²² (Kwasniewski, 2013)

German authorities accused a Spanish cucumber producer who later was proved to be innocent. The final result of the investigation was the accusation of a German sprout producer, whose business had to be closed down. But the German press is still discussing the aftermath as even these accusations have never been thoroughly proven³. The Spanish cucumber producer incurred heavy losses in business. The death toll of the contamination rose to 53 in the month of the investigations and 855 people were treated with life threatening complications.

Coming back to the juice industry, similar incidents might affect juice producers. And it could be similarly difficult to trace back the contaminations. With juice producers delivering their products on a national or even pan-European basis, the impact of contaminated goods might cause the same extensive damage.

Even without danger to consumers lives the economic damage to businesses can be extensive.

3.2 Procedural shortcomings

Every part of the supply and production chain controls for adverse influences which might have occurred during the last step in the chain. For example when fresh juice is delivered to a production facility it is tested for quality issues typical to occur during transportation. These being contamination due to substances transported in the tank prior to the juice. However, it is uncommon to test for contamination with pesticides or other substances which might have affected the fruit or the juice in earlier stages of production. Thus a faulty certificate from a plantation or an unreported contamination with untypical chemicals during juice extraction can find their way into the final product without getting noticed.

The interconnection between the European authorities in case of a contamination threatening the health of consumers, could be improved. It seems there is a lack of availability of data which causes investigation to take more time than they should. National databases could be linked, so that in case of investigations authorities can act on a pan-European knowledge basis. Technological advancements of the last decade have made this a feasible option.

3.3 Recommendations

Ever more sophisticated and affordable equipment might lead a way out of the dilemma of supply chain risks linked to contamination with microbiological or chemical substances. The testing of goods at the point of transfer from one company to the next could be broadened. Products could be tested for the accumulated possible contaminants of the whole supply chain so far, not only for contaminants introduced in the last process step. As a result the chance to detect fraud, bad practice and accidental contamination would be higher.

To be able to quickly react to new developments in scientific research, it is important to monitor the current research relating to the sector and direct the product development accordingly. For example it might be a good idea to have low caloric alternatives to 100% juices ready for market entry in case a link between 100% juices and diabetes is proven.

As probably the biggest risk to juice producers is the loss of reputation for their brands a generic mitigation strategy could be for each company to rely on multiple strong brands within the industry. To reduce the risk of scandal contagion or new dietary requirements further, producers should differentiate their brands in terms of supply partners and product strategies.

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