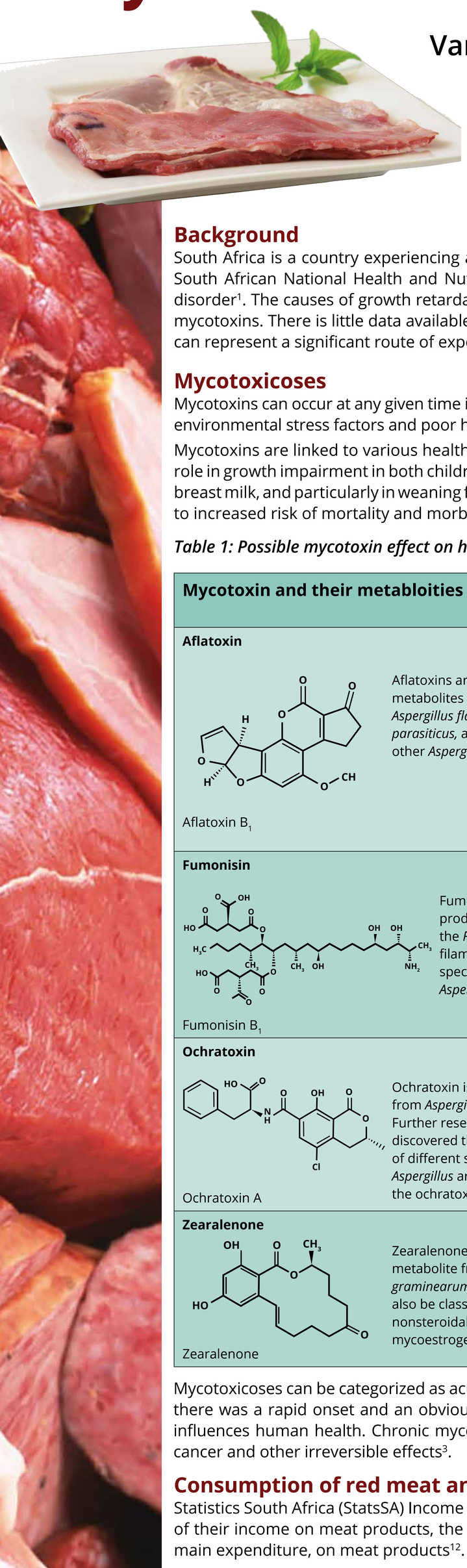
Mycotoxin occurrence in red meat and red meat products



Van Deventer, M. M#, Pretorius, B.* & Schönfeldt, H.C.*

School of Health Systems and Public Health, University of Pretoria
*Institute for Food, Nutrition and Well-being,
Department of Animal and Wildlife Science,
University of Pretoria, Pretoria, Gauteng, South Africa.

Contact: +27 12 361 2333 or mariciavandeventer@gmail.com

Background

South Africa is a country experiencing a nutrition transition, where both under- and over-nutrition increasingly co-exist. South African National Health and Nutrition Survey (SANHANES-I) reported stunting as the most common nutritional disorder[1]. The causes of growth retardation remain under hypotheses, but include exposure to toxic substances such as mycotoxins. There is little data available with regards to mycotoxin levels in animal products in South Africa. These foods can represent a significant route of exposure for humans.

Mycotoxicoses

Mycotoxins can occur at any given time if there is adequate conditions for fungi to grow. The African continent has both the environmental stress factors and poor handling and harvesting conditions that enable mycotoxins to contaminate crops.

Mycotoxins are linked to various health problems in both humans and animals. Aflatoxin appears to play a contributory role in growth impairment in both children and animals. Childhood exposure to mycotoxins can occur in utero, in mothers' breast milk, and particularly in weaning foods. Mycotoxin-associated health and growth impairment can, in turn, contribute to increased risk of mortality and morbidity in a population[2].

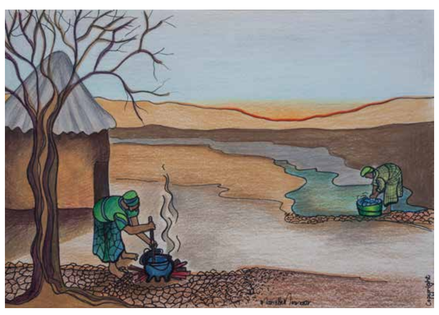
Table 1: Possible mycotoxin effect on humans and livestock

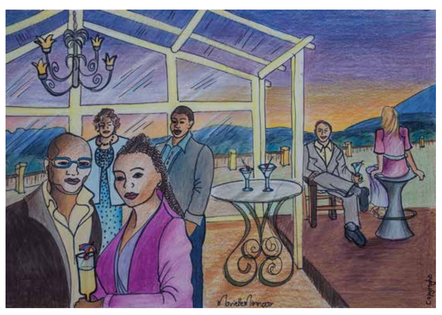
Mycotoxin and their metabloities	Possible effect on humans	Possible effect on swine	Possible effect on cattle
Aflatoxin Aflatoxin B_1 Aflatoxins are secondary metabolites of the fungi *Aspergillus flavus*, *Aspergillus parasiticus,* and occasionally other *Aspergillus species*[2]	• Liver cancer[4] • Stunting[4] • Stillbirths[4] • Liver cirrhosis[4] • Jaundice in newborns[4] • Enteropathy[4] • Malabsorption of nutrients[4] • Wasting[4] • Immune suppression[4] • Kwashiorkor[5]	• Intestinal haemorrhages[9] • Damage of the kidneys[9] • Pale and fatty liver[9] • Porcine pulmonary edema (PPE)[9] • Increased water consumption[9] • Fever[9] • Diarrhea[9] • Blood in faeces and urine[9] • Inflammation of the bladder and kidneys[9]	• Gastroenteritis[9] • Intestinal haemorrhages[9] • Impaired rumen function[9] • Diarrhea[9] • Ketosis[9] • Milk contamination[9] • Decreased milk production[9] • Mastitis[9]
Fumonisin Fumonisin B_1 Fumonisins are produced by both the *Fusarium*, a filamentous fungus species, and by *Aspergillus niger*[6]	• Oesophageal cancer[6]	• Intestinal haemorrhages[9] • Damage of the kidneys[9] • Pale and fatty liver[9] • Porcine pulmonary edema (PPE) [9] • Increased water consumption[9] • Fever[9] • Immunosuppression[9] • Pancreatic necrosis[9]	• Inappetence[10] • Weight loss[10] • Mild liver damage[10]
Ochratoxin Ochratoxin A Ochratoxin is a metabolite from *Aspergillus ochraceus*. Further research discovered that metabolites of different species *Aspergillus* are also part of the ochratoxin family[3]	• Balkan endemic nephropathy (fatal kidney disease)[7]	• Intestinal haemorrhages[9] • Damage of the kidneys[9] • Pale and fatty liver[9] • Immunosuppression[9] • Pancreatic necrosis[9]	• Increased water consumption[11] • Increased urination[11] • Permanent scarring of the kidneys[11]
Zearalenone Zearalenone Zearalenone is a secondary metabolite from *Fusarium graminearum.* It can also be classified as a nonsteroidal oestrogen or mycoestrogen[3]	•• Lipid peroxidation[8] • Inhibit protein synthesis[8] • Inhibit DNA synthesis[8] • Exert genotoxic effects[8]	• Irregular heats[9] • Abortion[9] • Pseudo pregnancy[9] • Low conception rates[9] • Ovarian cysts[9] • Embryonic Loss[9] • Tail necrosis[9]	• Irregular heats[9] • Low conception rates[9] • Ovarian cysts[9] • Embryonic loss[9] • Abortions[9]

Mycotoxicoses can be categorized as acute or chronic. The best known outbreaks of mycotoxicoses are acute cases where there was a rapid onset and an obvious toxic effect. Chronic mycotoxicoses on the other hand is the true burden that influences human health. Chronic mycotoxicoses is due to low-dose exposure over a long period of time that leads to cancer and other irreversible effects[3].

Consumption of red meat and red meat products

Statistics South Africa (StatsSA) Income and Expenditure Survey 2010/11 reports that marginalised consumers spent 22% of their income on meat products, the middle-class group spent 26% and wealthy consumers spent 27%, which is their main expenditure, on meat products[12].





Meat consumption in South Africa has increased drastically in the last decade. Many factors such as the current economic state of the country as well as the rising unemployment levels will influence meat consumption. However, due to the increase in income and the rising development in the coming decade it is still believed that meat consumption will rise (Figure 1)[13].

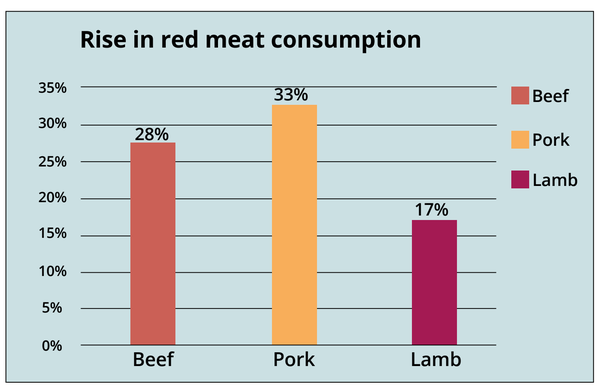


Figure 1: Estimated rise in consumption of red meat in South Africa in the coming decade[13]

Pathways of contamination

Meat products can be contaminated with mycotoxins via two methods. Firstly, meat can become contaminated with mycotoxins if the animal is fed mycotoxin contaminated feed. Secondly, meat can become contaminated during processing, packaging or in air-dried meat products[6].

Regulations regarding mycotoxins

Current regulations for feed and food in South Africa does exist. Act no. 36 of 1947 (Fertilizer, farm feeds, agriculture remedies and stock remedies act, 1947)[14] extensively regulates acceptable levels of mycotoxins in feed yet Act no. 54 of 1972 (Foodstuffs, cosmetics and disinfectants act, 1972)[15] only regulates aflatoxin B1 and M1, ergot fungus and patuline for foodstuff (Table 2).

Table 2: Mycotoxin regulations for foodstuff in South Africa

Food stuff	Maximum levels[15]	Maximum level Codex[16]
Peanuts, intended for further processing	15 µg/kg of total aflatoxin	15 µg/kg of total aflatoxin
Foodstuff ready for consumption	10 µg/kg of total aflatoxin of which aflatoxin B_1 is more than 5 µg/kg	• 4000 µg/kg fumonisins in raw maize grain • 2000 µg/kg fumonisins in maize flour and maize meal • 5 µg/kg of ochratoxin A in wheat • 5 µg/kg of ochratoxin A in barley • 5 µg/kg of ochratoxin A in rye
Milk	0.05 µg/L of aflatoxin M_1	0.5 µg/kg of aflatoxin M_1

Conclusion and recommendation

Strategies should focus on reducing mycotoxin exposure in diets, in ways that are cost effective and technically feasible. In a country such as South Africa where stunting and various other malnutrition conditions are common it is important to assess the mycotoxin intake of the population to determine high risk areas.

Red meat is consumed by both urban and rural communities in South Africa. The consumer is at risk of mycotoxin exposure as mycotoxins are found in muscle tissue of animals that have been fed mycotoxin contaminated feed. Currently there is a lack of knowledge about mycotoxin contamination in South African red meat.

The general lack of knowledge and the role that mycotoxin exposure plays in South African diets, in particular the effect of contaminated red meat, must be addressed and the following studies are recommended:

- To identify red meat products most often consumed in the diverse South African population.
- To describe mycotoxin levels of these identified red meat products.
- To increase availability of educational information on avoiding mycotoxins in red meat products.

Acknowledgements
This work is supported by Red Meat Research and Development South Africa (RMRDSA).

References

1 Shisana, O. et al., 2014. South African National Health and Nutrition Examination Survey (SANHANES-I), Cape Town: HSRC.
2 Khlangwiset, P., Shephard, G. S. & Felicia, W., 2011. Aflatoxins and growth impairment: A review. Critical Reviews in Toxicology, 41(9), pp. 740-755.
3 Bennet, J. W. & Klich, M., 2003. Mycotoxins. *Clinical mycrobiology reviews*, pp. 497-512.
4 Grace, D. et al., 2015. International agricultural research to reduce food risks: case studies on aflatoxins. *Food Security*, pp. 569-582.
5 Shephard, G. S., 2003. Aflatoxin and Food Safety: Recent African Perspective. Journal of Toxicology: Toxin Review, pp. 267-286.
6 Sorensen, L. M., Mogensen, J. & Nielsen, K. F., 2010. Simultaneous determination of ochratoxin A,mycophenolic acid and fumonisin B2 in meat products.. *Analitical Bioanal Chemistry*, pp. 1535-1542.
7 Pfohl-Leszkowicz, A. &. M. R. A., 2007. Ochratoxin A: An overview on toxicity and carcinogenicity in animals and humans. *Molecular nutrition & food research*, pp. 51(1), 61-99.
8 Gao, F. et al., 2013. Genotoxic effects induced by zearalenone in a human embryonic kidney cell line. *Mutation Research*, pp. 6-10.
9 Biomin, 2015. *Mycotoxins: Biomin*. [Online] Available at: http://www.biomin.net/
10 Osweiler, G. D., 2014. *Toxicology: Merck*. [Online] Available at: www.merckvetmanual.com
11 Parish, J., 2008. Mycotoxins and their effects on beef cattle. *Cattle business in Mississipi,* February.
12 STATS SA, 2011. *Income and Expenditure Survey 2010/11*, Johannesburg: STATS SA.
13 BFAP, 2015. *South African Outlook: Meat*, s.l.: BFAP.
14 Department of agriculture, forestry and fisheries, 2010. Fertilizers, farm feeds, agricultural remedies and stock remedies act, 1947 (ACT NO. 36 of 1947). *Government Gazette,* 32935 (No. R. 70), p. 14.
15 Department of Health, 2008. Foodstufffs, cosmetics and disinfectants act, 1972 (ACT NO. 54 of 1972). Government Gazette, 31022(No. R. 512), p. 2.
16 Codex. 2015. Codex general standard for contaminants and toxins in food and feed. STAN 193-1995