

Thymox Disinfectant to Increase Biosecurity in Poultry

Aleks Kus

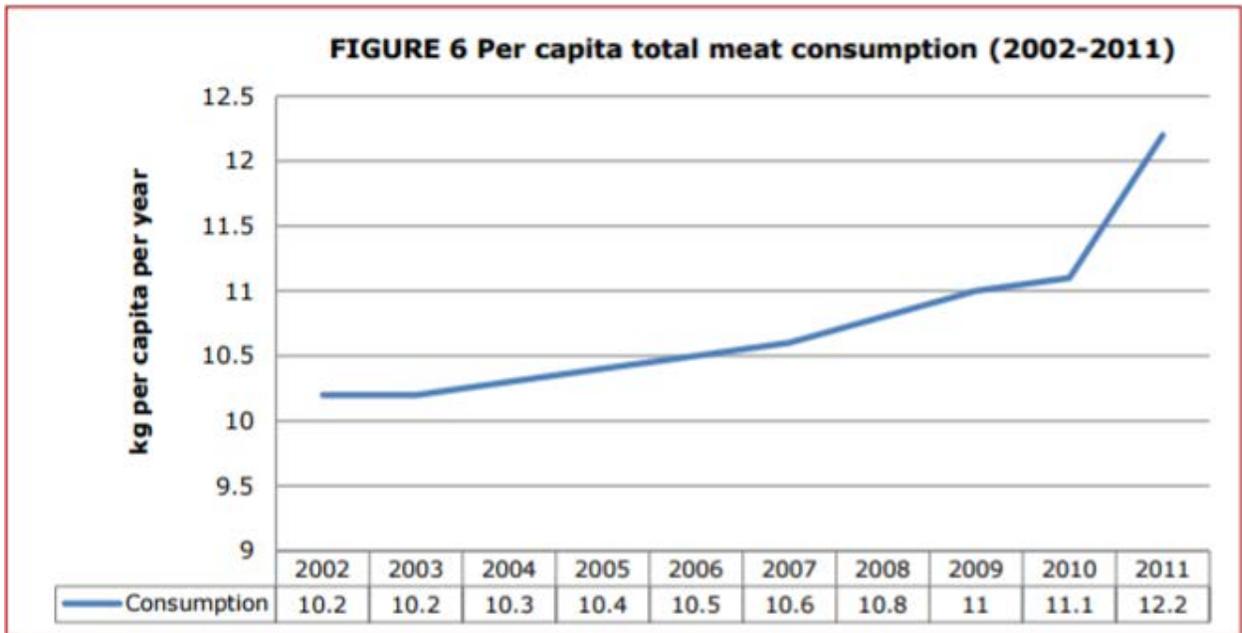
Part 1

Introduction

Located in South East Asia is a small country is known formally as the Federal Democratic Republic of Nepal, or more commonly as Nepal. The population of Nepal is currently 29,033,914 as of a 2016 July estimate with an area of 147,181 km². The main language in Nepal is Nepali and 80.6% of the population is of the Hindu religion (US Government 2016). In comparison with Canada, Nepal has a similar population, but in a much smaller area, leading to a much higher population density. In Nepal, 68% of the population is involved in the agriculture and forestry sector producing 34% of the country's GDP (USAID 2016). Despite such a heavy involvement in agriculture, farmers in Nepal are unable to produce enough food to overcome the food deficit they are currently experiencing. Currently, 25% of the citizens are below the poverty line. There are many factors that contribute to the food deficit that Nepal has such as, crippling earthquakes, lack of technological advancement, increased population growth rate, and political conflict. Central Nepal was struck by a 7.8 magnitude earthquake in April of 2015 and is still experiencing the repercussions to this date (Goda et al. 2015). Most farming in Nepal is subsistence farming, by local small farmers. They essentially grow and provide enough to feed their family, and a small profit as well for other needs. Nepal is separated into three distinct geographical regions for agriculture. The Mountains, Hills, and Terai (US Government 2016).

i. Poultry Industry

In Nepal, there has been significant development in the poultry sector. In 2002, the population of poultry nationally was 21.37 million and has since climbed to 45.17 million as of



Source: Food and Agriculture Organization of the United Nations (FAO) 2014

2012 with a 17-18% growth rate being maintained. 46.6% of said poultry is spread throughout rural Nepal and the other 54% is in larger commercial type farms, on the proximal outskirts of urban epicenters. Most poultry farming occurs in the Hill and Terai regions, at 19.9 and 17.6 million respectively. Consumption of poultry meat has risen drastically from 2002-2011 (Animal Production and Health, 2011).

Now that poultry production is more prevalent in Nepal, the risk of disease and infection is also. There are 3 different FAO definitions of poultry production systems in Nepal; Industrial and integrated, commercial and village/backyard. As well as 4 different sectors of production, ranging from Sector 1 to 4. Sector 1 includes industrial and integrated systems, Sector 2 includes commercial systems with birds being housed indoors constantly and higher biosecurity practices,

Sector 3 includes commercial systems but birds with birds being let outdoors partially and lower biosecurity practices while Sector 4 is village/backyard farms with birds remaining outdoors for most the day and very poor biosecurity practices. Farmers operate in a manner of 3 styles, scavenging, semi-scavenging or intensive. A scavenging system entails a farmer having 3-10 birds with little addition of food or medicine and using the eggs for a small income. Nearly 50% of all homes in Nepal own a small flock utilizing a scavenging system. In contrast, a semi-scavenging system is very similar except flock sizes are larger, a structure or shed is used to provide partial shelter to the birds and there are more human inputs of feed and medication. Lastly, intensive farms are more heavily managed and monitored, with birds spending all their time indoors under predetermined environmental conditions (Animal Production and Health, 2011).

Egg production in Nepal also has a more distinguished presence with a total of 7.48 million laying hens in 2010/2011 compared to 6.68 million in 2003/2004, with statistics rising since then. A change in dietary habits in Nepal, as well as an increased export to China and India has also been a factor in the growth of the poultry industry (Animal Production and Health, 2011).

Product Information

Proper biosecurity practices are essential in poultry operations. Clean and disease free facilities are paramount to maintaining flock health, increasing production, increasing feed conversion ratios, and decreasing morbidity to ensure that birds will make it market in a healthy condition. One of the most common pathways for infection is a barn being exposed to materials or traffic containing a pathogen, through materials introduced or human/wildlife visitation. In Nepal, there is miscommunication between commercial/industrial farms and the government in regards to disease recording. This makes disease management practices difficult to establish

because inept information is being used to establish practices. Most disease recording is conducted on backyard and smaller commercial farms and this creates a greater risk for the smaller farms as the government is unaware of what disease are prevalent (Sharma B, 2010). Since backyard farms are common, birds are often kept in proximity of human dwellings. Improper biosecurity management in these farms creates a risk to the human population as many zoonotic diseases are transmissible between humans and poultry (Sharma B, 2010). Especially disease such Highly Pathogenic Avian Influenza. Considering a widespread outbreak of HPAI in 2009, the Nepali government has begun to enforce more efficient biosecurity management. Three important factors in biosecurity management in poultry are isolation, traffic control and sanitation (Neupane et al. 2012).

Thymox Ag Disinfectant is a hard surface disinfectant developed by Laboratoire M2, situated in Sherbrooke, Quebec, Canada. It is composed of natural active ingredients, with the molecule Thymol being the active component (Laboratoire M2). Thymol is derived from thyme oil. It is a broad-spectrum disinfectant and it is known to be effective against, bacteria, fungi, and viruses, including; Staphylococcus aureus, Salmonella cholera etuis, Pseudomonas aeruginosa, Influenza A and others.

Labour Requirements & Application

Thymox is very easy to use and does not require a significant amount of labour in application. Depending on the type of farm that it is being used on, it can be applied and used in several ways in regards to the three main factors of critical biosecurity practices. For small backyard farms with a structure, it can be used to disinfect any new or foreign equipment entering a farm or persons entering a barn. Proper



http://www.hardisprayer.com/index.php?main_page=product_info&products_id=169&zenid=6571c387d182c9009764f0f4cc4de4ce

periodic disinfection of feeders and drinkers with Thymox would greatly reduce the risk of disease transmission. By simply disinfecting the boots of an individual or maintaining a footbath at the entrance, persons will minimize exposure to the birds in respect to traffic. If farms can employ an all in/all out production system, Thymox can be used to completely disinfect the facility in between flocks. For small farms, a simple handheld compression sprayer can be purchased for a relatively low cost (20\$), or for larger facilities with access to pressurized water systems a foamer/sprayer hose attachment can be used. For even larger commercial facilities, Thymox can be incorporated into a pressure washer system for widespread application. To be considered effective, it must be diluted to at least a 1% dilution rate, and be left on surfaces for at least 3 minutes. (Lemire 2016). Therefore a 4L jug would be useful for a total solution volume of 400L.

Health Information

One major focus of the Nepalese government in regards to proper bio-security is environmental friendliness. Commercial farmers are required to maintain their facilities in accordance with the Environment Protection Act 2055 (Sharma B, 2010). Harsh chemicals and detergents for cleaning and sanitation are not suitable with such a goal. Fortunately, Thymox Ag is not harmful to the environment. It is 100% biodegradable in less than 14 days and is non-toxic and non-irritating. It is the first Canadian disinfectant to obtain UL EcoLogo certification for reduced environmental impact. Since it is non-toxic and non-irritating it is safe to be used around the animals without any ill effects. Precautionary measures should be taken when handling large quantities of Thymox, prior to dilution, such as gloves and safety glasses (Laboratoire M2, Lemire 2016). Many chemicals that are used currently, such as Virkon are also non-toxic to humans and animals, but the concentrate used for dilution is extremely corrosive to skin and the

product does not biodegrade as efficiently as Thymox. The active ingredient in Thymox is the molecule Thymol (derived from thyme oil), whereas the active ingredient in a disinfectant like Virkon is potassium peroxomonosulfate, an oxidizing salt (DuPont 2010). A common chemical used in more industrial systems would be a multiphenolic, such as AGRI-CLEAN where many precautions and preventive measures must be taken to avoid severe burns on skin and inside the respiratory tract (Aspen Veterinary Services 2013).

Patents and Registration

The company that has developed Thymox Ag Disinfectant, Laboratoire M2, holds the patent for THYMOX TECHNOLOGY. Thymox technology refers to the method of isolating the molecule thymol from thyme oil and using that, with their patented formula, as the active ingredient in a line of products. Through Health Canada, Thymox is registered as a Hard Surface Disinfectant (Laboratoire M2).

Benefit to Manufactures

Laboratoire M2 is a small company located in Sherbrooke, Quebec, Canada consisting of only 10 employees spanning from production, research and development, sales to administration. The company is very small, but they also utilize many sub-contractors (Beaudoin 2016). As Thymox is the first company to develop this technology, they put a considerable amount of focus on research and development, to further progress their research. A trade opportunity to Nepal could increase income to Laboratoire M2 which they could invest into further product development. More profits from a new market such as Nepal could be used to expand their company in size. An increase in employees would also coincide with an increase in research and development. The purchase of Thymox products puts food on plates for 10 or so Canadian lives

and many subcontracting companies. Trade opportunities with Nepal could create more Canadian jobs with the possibility of gaining traction in other international markets.

Part 2

Transportation Route

As Nepal is a landlocked country, they do not have an international shipping port where they would receive imports. Instead items that are small enough in size can be imported via Air Freight, whereas larger items would need to be shipped via Ocean Freight to Kolkata, India and then transported by vehicular means into Nepal. To ship a box of 4, 4L units by air freight from Montreal to Kathmandu, it would cost approximately 300\$ CAD. 20L quantities of chemicals typically are stored in square jerrycan jugs, the cost of shipping 1 unit would be 325\$ CAD with rates from A1 Freight Forwarding using Air Freight, located out of Maple, ON, a suburb of Vaughan, ON (A1 Freight Forwarding). Using Ocean Freight, to ship a container of 4 units, it would cost 337\$ USD and nearly the same to ship a 20L unit. As Laboratoire M2 is in Sherbrooke, Quebec items would be shipped from Canada's Montreal port, to the Tianjin Xingang port in China, from the Tianjin Xingang port it would be sent to the Kolkata port of India and then transported by a large freight vehicle into Nepal, reaching Kathmandu or other city of destination (Cargo Router). For items being sent by Air Freight, they would be sent from the Montreal – Pierre Elliot Trudeau International Airport to the Tribhuvan International Airport in Kathmandu and then transported by vehicle to its destination.

For Thymox to be shipped and exported internationally, there are several criteria that must be met. One would need an export certificate, pertaining to the jurisdiction the item belongs to. ThymoxAG disinfectant is registered as Hard Surface Disinfectant under Health Canada and

therefore must comply with the Food and Drugs Act. The proper documentation must be filled out, packaged with, and the package must be written on clearly, with the word “Export” (Health Canada, 1989).

i. Storage

Many chemicals when shipped are classified as dangerous goods and must comply with the Transportation of Dangerous Goods Canada services, but one of the benefits of Thymox is that it is dilute enough to reduce any risk of flammability, except at 62°C with ignition. This makes it safe for transportation. Storage requirements found on the MSDS sheet indicate that the product should be kept in the original container, tightly sealed at a temperature of below 30°C (Lemire 2016).

Cost Analysis

Chemical disinfectants can be very expensive, but to Canadian poultry farmers the expense is considered a necessary and common practice and there is little consideration when equating a budget. In Nepal, many of the smaller poultry farms are not able to afford expensive chemicals and materials. 24.8% of the population in Nepal is below the poverty line (Animal Production and Health, 2011). The price of Thymox Ag Disinfectant is \$296.00 for 4 units of a 4L bottle, \$350.00 for a 20L bottle, \$2940.00 for 200L and \$13 300.00 for 1000L (Beaudoin 2016). These prices are direct from the manufacturer. For a farmer to purchase one unit of a 4L bottle, it would cost them \$74 CDN. In Nepal that would equate to roughly 6069\$ Nepalese Rupee's. For a box of 4, 4L bottles, it would cost \$24 275.82 Nepalese Rupee's, \$28 704.51 for a 20L bottle, \$241 117.91 for 200L and \$1 090 771.50 for a quantity of 1000L. In Nepal, the GDP per capita is 732.3 USD, or \$80,474.21 Nepalese Rupee (The World Bank Group 2016).

For someone in Nepal to purchase 1 unit of a 4L quantity of Thymox Ag, it would cost them 7.50% of an average person's annual income. GDP per capita in Canada is \$69 691.77 CAD after converting from USD (The World Bank Group 2016). In comparison, for a Canadian citizen to spend 7.50% of their GDP per capita, it would be equivalent to purchasing an item valued at \$5 226.88 CAD, comparable to buying a new used vehicle. For a Nepalese citizen to buy 4 units of a 4L quantity it would 30.2% of GDP per capita. Surpassing a quantity of 200L is not a realistic purchasing point for an average citizen with a small backyard farm, but for a larger commercial farm purchasing a 20L quantity would be realistic in usage and affordability. Thymox also includes freight charges in their list prices.

Format/Size	Bte/Box 4x 4L	20 L	200 L	1000 L
Prix/Price	296,00\$	350,00\$	2 940,00\$	13 300,00\$
FRAIS DE TRANSPORT/ FREIGHT CHARGES				
399\$ ET MOINS/ 399\$ AND LESS	400\$ ET PLUS/ 400\$ AND OVER	700\$ ET PLUS/ 700\$ AND OVER		
NON INCLUS/ NOT INCLUDED	Sans frais/No charge Québec et/and Ontario	Sans frais partout au Canada/ No charge throughout Canada		

(Beaudoin 2016)

When a customer spends less than \$399, the freight charges are not included, but when spending over \$400 there is no charge throughout Quebec and Ontario and no charge throughout Canada when spending more than 700\$ which would only be applicable if one was to purchase the box of 4, and then distribute only 1 unit at a time, reducing shipping costs. As the prices for Thymox are already significant when converted to the NPR, and in comparison, to the GDP per capita it would only increase the purchasing price exporting to Nepal.

As mentioned in *Transportation Route*, it would cost \$300 CAD to ship a box of 4, 4L units by air freight from Montreal to Kathmandu. The cost of shipping 1 20L unit would be 325\$. Using Ocean Freight, to ship a container of 4 units, it would cost 337\$ USD and nearly the same to ship a 20L unit using A1 Freight Forwarding rates. To ship units of greater quantity it would not be cost effective as the average Nepali person would not be able to afford the product itself, or the steep shipping rates. Large commercial farms may be able to afford larger than 20L quantities but that could be introduced at a later stage of marketing, as the reputation of Thymox is unprecedented.

Benefit

People in Nepal will greatly benefit from this product. More specifically, poultry farmers. As the risk for disease in the poultry industry is very high, mitigating biosecurity practices is a necessity. In Nepal from the year 2002 to the year 2006, there was nearly 1.3 million birds affected resulting in just over 100,000 deaths from only 5 common poultry diseases (Coccidiosis, Respiratory Disease, IBD, Newcastles Disease and Pullorum disease) (Sharma B, 2010). Infectious Bursal Disease and Coccidiosis are capable of surviving months at time separated from a bird host. Newcastle's Disease and pullorum disease (salmonellosis) can survive for days to weeks away from a bird host (Sharma B, 2010). This quality of these diseases makes them more dangerous as simply removing waste may be ineffective as bacterium and protozoa can survive for such expansive timelines. In 2009, Nepal experienced their first outbreak of HPAI

and this triggered a surge in biosecurity. In a study conducted by BMC Infectious Diseases shortly after the outbreak, they had discovered that poultry workers had knowledge in regards to basic biosecurity measures, such as handwashing, but were lacking intel in more intensive practices, such as cleaning surfaces and protective clothing (Neupane et al., 2012). It is evident that when asked of biosecurity behaviours, only 22.9% mentioned washing and disinfecting surfaces, while of the 22.9% only 40.6% had stated that they performed this behaviour regularly.

Table 1 AI Knowledge and preventive practices among poultry workers (N = 96)

Variables	Knowledge ¹	Practices ²
	%	%
Wash hands with soap and water	88.5	100
Use face masks	53.1	27.1
Use gloves	68.8	30.2
Use special boots or boot covers	15.6	7.3
Use special body garments	8.3	3.1
Wash and disinfect utensils	28.1	40.6
Wash and disinfect surfaces	22.9	40.6

¹Percentage of poultry workers naming the specific behaviour when asked to list all protective practices against AI

²Percentage of poultry workers indicating they were always or often using this practice

(Neupane et al., 2012)

Although the number of samples was only 96, the results display an accurate portrayal of the reality of poultry workers in Nepal. HPAI is transmissible to humans, and fortunately there were no reported human incidents of HPAI. But it is possible, especially with lack of biosecurity practices, that a human epidemic could be initiated and the

Healthcare sector would be overwhelmed. As Thymox Ag Disinfectant is a broad-spectrum disinfectant it would be effective in killing viruses, bacteria and fungi that infect and detriment poultry, with the possibility of an epidemic in humans as well.

As there are 4 different sectors of poultry production systems in Nepal, the smaller backyard and smaller commercial farms who do not enforce stringent biosecurity practices would benefit from Thymox the most. At a moderate price, and a simple inexpensive delivery system (compression sprayer), basic practices could decrease disease considerably. For the larger, completely indoor, commercial farms they would also benefit from using Thymox. They

would be able to afford purchasing larger quantities and having the means to use higher quantities. Larger commercial farms would be more than likely to employ all in/all out systems and can disinfect the barn with Thymox in between flocks. Whereas smaller farms would just be disinfecting drinkers, feeders, persons entering, equipment entering and the barn when applicable. But backyard farms that employ solely scavenging systems would not benefit from Thymox overly as their birds are free to roam and are more susceptible already. The cost of Thymox relative to the net profit of owning 3-10 birds would be difficult to surmise. Thymox would also not be damaging to the environment, providing an added benefit to farmers who live in more rural areas where the ecosystem around them is of the utmost importance.

Marketability

i. Strategies

Once the product has been brought into Nepal, gathering the attention of local farmers could be a difficult task. One method that would prove to be useful is collaborating with companies or organizations that run seminars to teach those in the poultry industry about being a poultry farmer. One organization that does such is Practical Action, who focus on reducing poverty in Nepal through the spread of information about technologies, ranging from education to water management. In 2010, Theminkosi Nyathi authored a publication (Nyathi 2010) entailing practices in indigenous poultry farming. A possible partnership between the University of Guelph and organization as such could be established, demonstrating or illustrating basic and advanced methods that could increase biosecurity through means of disinfection with the extremely environmentally friendly product, Thymox, for small backyard farmers. For larger commercial farmers, establishing a connection with a large veterinary or animal supply supplier

such as Arohan Vet Pharma would be optimal. They are located in a larger village named Sitapaila, in the Kathmandu District of Nepal in the Bagmati Zone in Central Nepal (Business1.com B.V 2016). The location of Arohan Vet Pharma is advantageous because it is central to Nepal, and is accessible to many of the larger commercial farms as they tend to be situated just outside of larger cities.

ii. Competition

By highlighting the environmental benefits to using Thymox compared to other products, this would hopefully attract a larger consumer base. One large competitor known worldwide that is comparable to Thymox is Virkon (Lanxess 2016). Virkon is world renowned for their Virkon S brand. It is known to be effective against 500 common strains of virus, bacteria, and fungi including those common in the poultry industry. Many governments agencies utilize it also. It is sold in a powder form and then mixed with water to create a solution that is applied in the same manner as Thymox (found in *Labour and Application*) (Lanxess 2016). One major competitive edge that Virkon S has against Thymox is its known 100% effectiveness at eliminating the Newcastle Disease virus. A persistent and imminent threat to Nepal poultry farmers.

A 4L jug of Thymox valued at \$74 CAD is effective in producing 400L of usable solution in disinfection, whereas a 10lb pail of Virkon S valued at \$78.96 USD (Amazon 2016) is effective for creating a total solution volume of 453.592 L at a 1% dilution rate. Both products are similar in cost and application, but Thymox has the advantage of being 100% biodegradable whereas Virkon S is not. This would be a very important factor considering the environment where it is being used. Thymox is cheaper than Virkon S as well, making it more affordable for Nepalese poultry farmers.

Conclusion/Feasibility

In a final analysis, Thymox Ag Disinfectant developed by Laboratoire M2 out of Sherbrooke, Quebec would be beneficial to poultry farmers in Nepal. As an environmental concern presides over the future of Nepali disease management, using Thymox as an alternative to harsh chemicals would be positive for Nepal's ecosystem. The rising concerns of disease incidence must be dealt with for poultry farmers to increase yields and profits. Using Thymox could reduce disease spread and result in smaller backyard farms having lower morbidity and being able to grow their farms to a larger size and provide for their family in greater means. Thymox is expensive for Nepalese farmers to purchase, but the initial investment of purchasing would be a long-term benefit that would increase profits, resulting in continued usage and continued growth. As Thymox Ag is available in a box of 4, 4L bottles, it would not be necessary for one person(s) to purchase all 4, but small groups of individuals could collaborate to minimize overall shipping costs. As of 2011, in Nepal there was a total of over 1000 broiler farms and 500 layer farms and in the larger cities, with 82% of largely populated cities' poultry being from commercial farms (Animal Production and Health, 2011). This creates an excellent market for Thymox. Larger commercial farms are already known to be stringent on biosecurity practices and introducing Thymox Ag Disinfectant at smaller volumes, it could open a market for Canadian export while reducing their ecological footprint.

Effectiveness of Thymox is not noted factually, but only reported and speculated on. One source claims that in the bovine livestock industry, a similar Thymox product for infectious claw diseases is a possible alternative to standard treatments but that further research needs to be conducted to prove efficiency (Kulow et al. 2015) . For Thymox to gain widespread momentum

as a renowned and effective disinfectant in the poultry industry, further research needs to be conducted in practical scenarios.

References

- US Government. (2016, November 10). The World Factbook: NEPAL. Retrieved November 29, 2016, from <https://www.cia.gov/library/publications/the-world-factbook/geos/np.html>
- USAID. (2016, April 15). Agriculture and Food Security Nepal. Retrieved November 29, 2016, from <https://www.usaid.gov/nepal/agriculture-and-food-security>
- Goda K, Kiyota T, Pokhrel RM, Chiaro G, Katagiri T, Sharma K and Wilkinson S (2015) The 2015 Gorkha Nepal earthquake: insights from earthquake damage survey. *Front. Built Environ.* 1:8. doi: 10.3389/fbuil.2015.00008
- Animal Production and Health, FAO. (2011). Poultry Sector Nepal.
- Sharma B. (2010). Poultry Production , Management and Bio-Security Measures. *The Journal of Agriculture and Environment*, 11, 120–125. <https://doi.org/10.3126/aej.v11i0.3659>
- Neupane, D. ., Khanal, V. ., Ghimire, K. ., Aro, A. R. ., & Leppin, A. . (2012). Knowledge, attitudes and practices related to avian influenza among poultry workers in Nepal: A cross sectional study. *BMC Infectious Diseases*, 12, 76. <https://doi.org/10.1186/1471-2334-12-76>
- Laboratoire M2. (2016). Farm Disinfectant Manufacturer | Thymox. Retrieved October 19, 2016, from <http://www.thymox.com/products/animal-health-farm-disinfection/>
- Lemire, G. (2016, May 10). Thymox Surface Disinfectant Technical Sheet. Retrieved November 29, 2016, from <http://www.thymox.com/thymox-surface-disinfectant-technical-sheet/>

DuPont Chemical Solutions Enterprise. (2010, November 2). Virkon S. [Material Safety Data Sheet]. Retrieved from https://www.valleyvet.com/Library/lib_30824_-Msds.pdf

Aspen Veterinary Resources. (2013, October 13). AGRI-CLEAN [Material Safety Data Sheet]. Retrieved from <https://animalhealthinternationalvet.compassites.com/product/view/7461099>

Beaudoin, L. (2016, October) Email communication.

A1 Freight Forwarding. (2016, November 29). Shipping to Nepal from Canada: Air Freight & Air Cargo. Retrieved November 29, 2016, from <http://www.a1freightforwarding.com/country/nepal-2/>

Cargo Router. (2016, November 29). Freight from Montreal, Canada to Hetauda, Nepal. Retrieved November 29, 2016, from <http://www.cargorouter.com/freight-shipping/Canada/Montreal/Nepal/Hetauda/>

Health Canada. (1989). Food and Drug Regulations Règlement sur les aliments et drogues, 617–620.

The World Bank Group. (2016). GDP per capita (current US\$). Retrieved November 29, 2016, from <http://data.worldbank.org/indicator/NY.GDP.PCAP.CD>

Nyathi, T. (2010). Improved Practices in Indigenous Poultry Farming - Practical Answers. Retrieved November 29, 2016, from <http://answers.practicalaction.org/our-resources/item/improved-practices-in-indigenous-poultry-farming>

Business1.com B.V. (2016). Arohan Vet Pharma. Retrieved November 29, 2016, from

<http://arohan-vet-pharma.business1.com/>

Lanxess (2016). The Premium Broad Spectrum On Farm Biosecurity Solution. Retrieved

November 29, 2016, from <http://virkon.com/en/products->

[applications/disinfectants/virkon-s/](http://virkon.com/en/products-applications/disinfectants/virkon-s/)

Amazon (2016). Virkon S Powder, 10 lb Pail. Retrieved November 29, 2016, from

<https://www.amazon.com/Virkon-Powder-10-Pail/dp/B0042LA1IE>

Kulow, M., Zibae, F., Allard, M., & Döpfer, D. (2015). Short communication: Determination of

the ability of Thymox to kill or inhibit various species of microorganisms associated with

infectious causes of bovine lameness in vitro. *Journal of Dairy Science*, 98(11), 7899–7905.

<https://doi.org/10.3168/jds.2015-9551>

Images

http://www.hardisprayer.com/index.php?main_page=product_info&products_id=169&zenid=65

71c387d182c9009764f0f4cc4de4ce