Penicillium candidum culture for cheesemaking

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Nepal is a tiny piece of the world, but it is filled with towering mountains and crystal clear lakes, making it the perfect tourist destination. It is also a very impoverished country and approximately 80% of the population depends on subsistence farming to support their livelihood (IFAD, n.d.). The country's 147 181 square kilometers of land can be divided into three different regions as shown in figure 1 (Pandit and Bevilacqua, 2011). These regions are divided based on landscape and food production potentials: the terai region, the hilly region and the mountain/ Himalayan region (Pariyar, 1998). The terai region is the most fertile but only makes up 22% of the land base (Pariyar, 1998), leaving the rest of the farmers operating on marginal land that is only capable of producing enough food for local use (Schroeder, 1985). Nepal has been subjected to countless landslides, earthquakes and floods that threaten the livelihood of the citizens (Ghimire, 2016), as well as the tourism industry that is integral for generating jobs for the local people. In 2014 the tourism sector provided 487 500 jobs in hotels, restaurants, and leisure industries such as mountain climbing and rafting (Post Report, 2015). These additional jobs have contributed to the steady rise in Nepal's Gross Domestic Product (GDP) per capita from 2002 when it was $251.04 to 2015 where it was $689.81 (Nepal GDP per capita, n.d.). In order to support the growing population, intensification of the agriculture industry will attempt to produce more food for the Nepalese people, while also producing value added products to benefit the farmer's yearly income and decrease the poverty rate (Dahal, Sitaula, & Bajracharya, 2007).

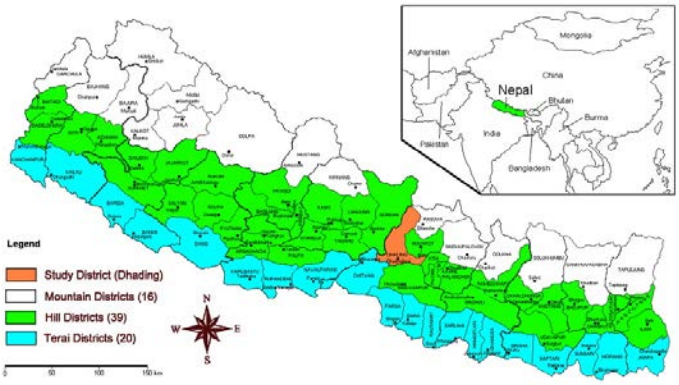

Figure 1. Map of Nepal's three different agro-ecological regions (Pandit and Bevilacqua, 2011).

In 1952 the first Yak cheese factory was established, and was closely followed by the establishment of two more cheese factories in 1960 as well as many private entrepreneurs producing cheese in the mountain regions (Food and Agriculture Organization (FAO), 2010). As of 2010 there was 13 cheese factories processing cow, yak and goat milk, but some cheese is still imported in order to meet market demands (FAO, 2010). In the future, as the population grows and yearly income increases, there is expected to be a higher demand for dairy products in urban markets (FAO, 2010). The cheesemaking industry is beneficial to the country because it supports Nepalese dairy

farmers, produces jobs for the local people and produces a product that can be sold to tourists.

Product description

The growth of fungal species on food usually indicates the spoilage of fresh and prepared foods, but in the case of some meats and cheeses, fungi plays an important role in the ripening and development of the taste and aroma associated with these foods (Laich, Fierro, & Martin, 2002). A particular species of fungus called *Penicillium candidum* (also known as *Penicillium camemberti*) is most frequently used as a starter for cheese production (Laich, Fierro, & Martin, 2002), meaning it is used to colonize the cheese with a desired fungus, preventing colonization by an undesirable fungus or bacteria (Laich, Fierro, & Martin, 2002). Fungi growth on food also has the potential to be harmful because of the production of mycotoxins and antibiotics (Laich, Fierro, & Martin, 2002). Antibiotics such as penicillin cannot enter the human food chain because it can lead to allergic reactions and has the potential to cause antibiotic resistance of human resident bacteria (Laich, Fierro, & Martin, 2002). *Penicillium candidum* is not a penicillin producer and will not cause problems down the road in regard to the presence of penicillin in food (Laich, Fierro & Martin, 2002). The most common types of cheese that are produced with the *Penicillium candidum* starter culture are Camembert, Brie and Camboloza, all of which are soft, white cheeses.

Penicillium candidum is grown in a fermentation vessel using a medium and growing conditions that are property of the individual manufacturing companies (S. Speich, personal communication, November 14, 2016). The bacterial cultures themselves are unable to be patented because they are constantly evolving and refined to suit consumer's cheese preferences (E. Kinloch, personal communication, October 17, 2016). Once the cultures are harvested from the medium they are freeze dried for distribution, and packaged into two different sized pouches, the first holding enough bacterial inoculant for 10 000L of milk, while the smaller pouch holds enough inoculant for 2000L of milk (E. Kinloch, personal communication, October 17, 2016). The cultures are packaged based on the activity level of the bacteria not the dry weight of the pouch contents, ensuring consistency from one batch of cheese to the next, but it makes the weight of each shipment different (E. Kinloch, personal communication, October 17, 2016). If the bacteria are not very active they will only inoculate a small amount of milk, but if the bacteria are very active, they will need a larger batch of milk to inoculate (E. Kinloch, personal communication, October 17, 2016). A variable amount of bacteria in each pouch prevents the cheese makers from constantly having to adjust their amounts of milk in each batch (E. Kinloch, personal communication, October 17, 2016).

Canada's involvement

A Canadian company called Danlac was established in 2012 and provides dairy and meat bacterial cultures worldwide (Danlac Canada, n.d.). Danlac is simply a distributor of the *Penicillium candidum* strain of bacteria, importing their products from

European countries such as Germany and France where the cultures are manufactured (E. Kinloch, personal communication, October 17, 2016). The company has two distribution warehouses in Canada, one in Brampton, Ontario and the other in Delta, British Columbia (E. Kinloch, personal communication, October 17, 2016). Although Canada does not produce any of the components associated with the production of the bacterial cultures, the indirect benefits include the employment of a total of 34 people, 14 of which work at the Delta warehouse and another 4 are responsible for ordering shipments of the culture packets from their suppliers (E. Kinloch, personal communication, October 17, 2016). Danlac sells three different white mould cultures that are all made up of *Penicillium candidum* spores, but have different chemical properties that can create a hard, robust rind versus a rind that is thin and fluffy (Danlac Canada, n.d.). The initial shipment will contain only one type of culture, the *Penicillium candidium* NEIGE (PC NEIGE LYO 10 D), which provides a white appearance to the cheese, ageing stability and aroma development (Danlac Canada, n.d.). The downfall of importing a finished product into Canada just to turn around and export it back overseas is the price inflation associated with shipping costs because Danlac will need to sell the bacterial cultures for an increased price to cover their shipping costs. The price to purchase of one 10 dose packet of PC NEIGE from Danlac is $10.98, whereas Danlac is able to purchase the packets for approximately $7.00 from their European supplier ((E. Kinloch, personal communication, October 17, 2016).

Danlac contact information:
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Shipping

In order for the cultures to arrive in Nepal's capital city of Kathmandu, they will travel approximately 11 021 km across the Pacific Ocean when shipped from the Delta warehouse or approximately 11 919 km across the Atlantic Ocean if there were shipped from Brampton warehouse (Canada Distance, n.d.). The Delta warehouse will be used to distribute products to Nepal because of the closer proximity and the ability to ship by sea to India, one of the two countries that boarders Nepal. The shipment of bacterial cultures will first have to be transported by truck from Delta, British Columbia to Vancouver, British Columbia, where it then has two transportation options as seen in figure 2, Vancouver International Airport or the Port of Vancouver. Although shipping by air will be more costly than shipping by sea, the bacterial cultures will be shipped directly to Nepal, which cuts down further trucking costs. Once the cultures arrive either by sea to West Bengal, India or by air to Kathmandu, Nepal, they will be trucked to Lainchour, Kathmandu. Table 1 outlines the costs that will be associated with the different routes of transportation. All prices are based on a 5kg shipment.

Each pouch of bacteria culture weighs approximately 5 grams, even though they are packaged based on activity level instead of weight (M. Morris, personal communication, November 14, 2016). The original shipment will contain 10 pouches, which will only weigh 0.5kg, and be packaged in an 18”x18”x18” box.

Table 1. Outline of costs associated with shipping from Canada to Nepal

Departure location	**Type of transportation**	**Arrival location**	**Shipping company**	**Cost (CAN$)**
Delta, BC (V3M 5P3)	Truck	Port of Vancouver (V6C 3T4)	Purolator	$18.97
			UPS	$19.17
			Canada Post	$21.01
Delta, BC	Truck	Vancouver International Airport (V7B 0A4)	Purolator	$18.97
			UPS	$19.17
			Canada Post	$21.01
Vancouver Airport	Air	Kathmandu, Nepal	A1 Freight Forwarding	$317.22
			UPS Air Freight Consolidated	$249.68

The most economical option to get the shipment from Delta to Vancouver is to use Purolator for a cost of $18.97. Once arriving at the Vancouver International Airport, the package will be sent via UPS Air Freight Consolidated for $249.68 to the Tribhuvan International Airport in Kathmandu, Nepal. Due to the size of the package it is very difficult to find a shipping company who will send the box in one of their containers, and it was suggested to pursuit a form of air transit instead (MSC, personal communication, November 24, 2016). The combined cost to get the shipment to Nepal is $268.65. From here it will be trucked by Eastern Cargo Movers Pvt. Ltd. to the cheese factory in Lainchour, Kathmandu.

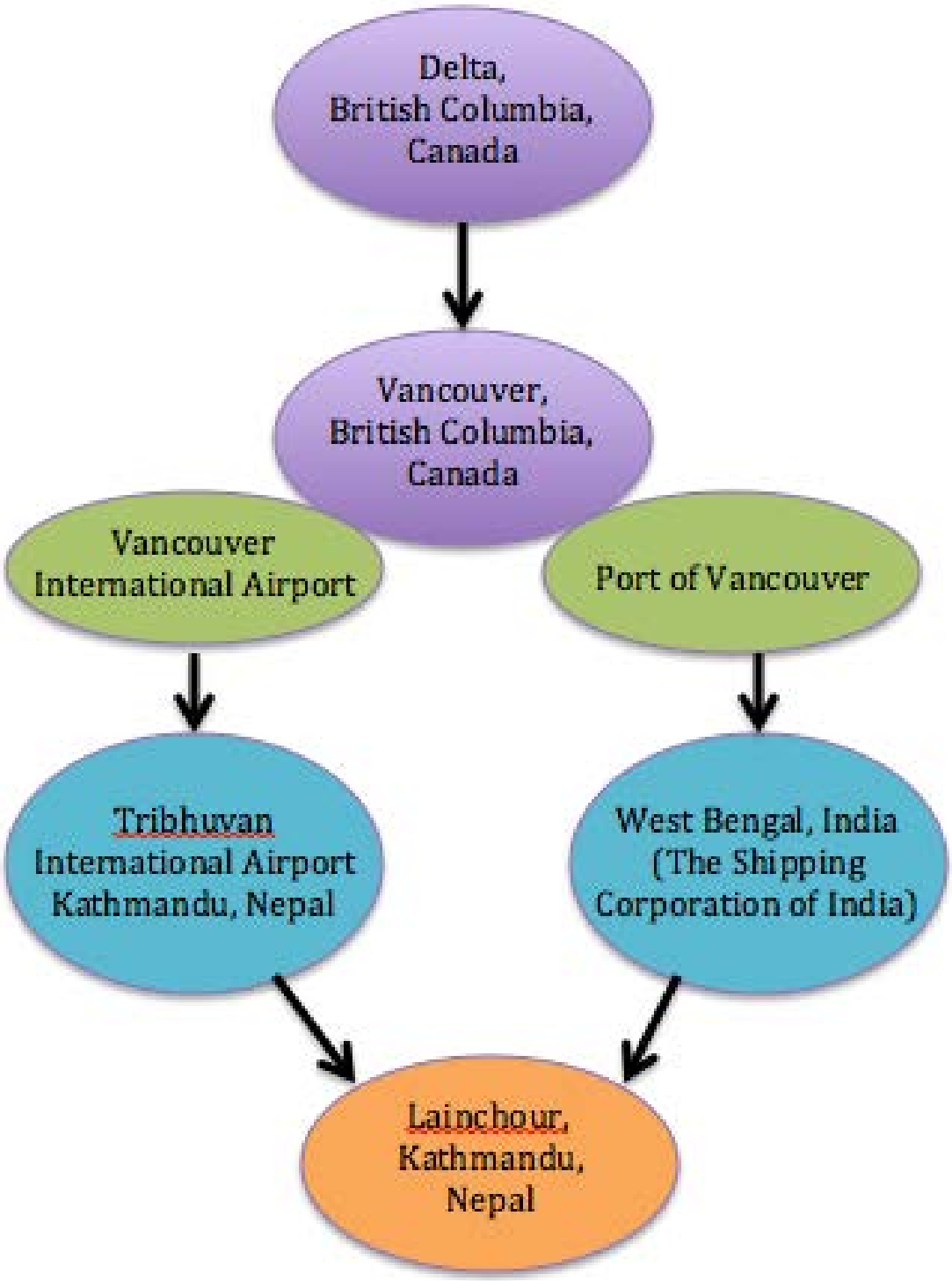

Figure 2. Map of transportation pathways from British Columbia, Canada to Kathmandu, Nepal.

While in transit to Nepal the cultures will remain viable at ambient temperatures, and can remain uncompromised for up to three weeks when living in this environment (E. Kinloch, personal communication, October 17, 2016). Once the shipment reaches Nepal, the culture packet will need to be stored at a temperature less than 4°C in a dry atmosphere, where it can survive for up to a year (E. Kinloch, personal communication, October 17, 2016).

Prospective buyers

Once in Nepal, the bacterial cultures will be bought by pre-existing cheese factories. The Dairy Development Corporation (DDC) began as a movement to economically stabilize poor farming communities and has grown to collect milk from over 75 000 dairy producers in Nepal (Dairy Development Corporation (DDC), n.d.). The DDC provides one-year advanced payments to their dairy producers to ensure its milk supply (Yonzon and Hunter, 1991). This milk is funneled into dairy plants, cheese factories and chilling plants where the milk is handled under strict quality and hygiene protocols (DDC, n.d.). One of the projects operating under the DDC is called the Milk Product Supply Scheme (MPSS) based out of Lainchour, Kathmandu, which produces Yak cheese, Kanchan Cheese, Spread cheese and Mozeralla Cheese (DDC, n.d.). The additional use of *Penicillium candidum* bacterial cultures in the MPSS will produce a new product that can be sold in urban markets and compete in niche markets with cheese products produced by private, specialty cheesemakers already producing Camembert and Brie cheese. Although producing another type of cheese in the factory may not be enough to generate more jobs for the Nepalese people, it may stimulate an interest in specialty cheese production beyond the city limits of Kathmandu.

Francois Driard, a Paris entrepreneur began Himalayan French Cheese when he decided it was time to bring the raw, smelly cheese of his homeland to Nepal (Magnier, 2011). Since it's establishment, Driard believes that he remains to be the only French cheese maker in the Himalayan mountains (Magnier, 2011), holding sole control over the specialty cheese market in this area. A Nepalese entrepreneur looking to produce a rare product could benefit from using *Penicillium candidum* starter cultures by selling their products in a niche market with very little competition. This would provide Himalayan dairy farmers with an alternate market instead of selling their milk directly to the DDC, but yearly advanced cash payments from the DDC ensures a source of cash for the subsistence farmers that they may be unwilling to pass up (Yonzon and Hunter, 1991).

Target consumer

Cheese is currently being produced in Nepal, but the current price to purchase cheese is well in excess of what a Nepalese person would be able to afford, so it is marketed as a luxury item to Western tourists (Yonzon and Hunter, 1991). One third of Nepal's population makes less than $14/month (1538.49 rupees), or $168/year (18 461.92 rupees) (IFAD, n.d.). One 250g block of Camembert cheese from the Himalayan French Cheese company retails for 600 rupees ($7.38 CAN), 3.25% of their annual income. The

cost of cheese marketed in Nepal is cheaper than the majority of European and North American prices, so if the price were increased, it would not damage the market and would also improve the living conditions of local people (Yonzon and Hunter, 1991).

Potential downfalls

Increasing the amount of cheese production in Nepal will require an increased amount of lactating animals to provide the liquid milk substrate necessary for production (Yonzon and Hunter, 1991). Increasing herd size can lead to overgrazing of pasture ground, especially in the hills and mountain regions where grass species are limited (Yonzon and Hunter, 1991). Seasonal fluctuations in rainfall also cause late maturity and reduced fertility when the animals are living in stressful environments during the dry season (Yonzon and Hunter, 1991). Once the grass is depleted, the large numbers of poorly nourished livestock are forced to browse on shrubs and trees causing degradation of the forest (Yonzon and Hunter, 1991).

Regional and global competition

There are distributors of cheese starter cultures located all around the world, but the vast majority of the warehouses distribute the same CHOOZIT™ product that is produced by Danisco®, a division of DuPont®. DuPont® is an innovative company that provides knowledge and research to the food and beverage industry, as well as having a very prominent global presence with offices in a large portion of the world's countries as seen in Figure 3. In addition to Dupont®, Table 2 outlines additional competition that Danlac faces when exporting *Penicillium candidum* bacterial cultures to Nepal.

AFRICA	OCEANIA	AMERICAS	ASIA	EUROPE
SOUTH AFRICA	AUSTRALIA	BRAZIL	CHINA	AUSTRIA
	NEW ZEALAND	CANADA	INDIA	BELGIUM
		CHILE	MALAYSIA	CZECH REPUBLIC
		COLOMBIA	SINGAPORE	DENMARK
		MEXICO	SOUTH KOREA	FINLAND
		UNITED STATES		FRANCE
				GERMANY
				ITALY
				NETHERLANDS
				NORWAY
				POLAND
				ROMANIA
				RUSSIA
				SERBIA
				SLOVAKIA
				SPAIN
				SWEDEN
				SWITZERLAND
				UKRAINE
				UNITED KINGDOM

Figure 3. List of DuPont® offices located around the world. Retrieved from http://www.dupont.com/corporate-functions/our-company/global-locations.html

Table 2. Distributors of *Penicillium candidum* bacterial cultures

Company Name	Location	Distance from Nepal	Product Name	Price CAN$
Fromagex	Rimouski, QC, Canada	11 148 km	SWING FD PCA-1/10U	$12.55
Dairy Connection	Madison, Wisconsin, USA	12 116 km	PC NEIGE LYO 10D	$14.71
Orchard Valley Dairy Supplies	Burford, Tenbury Wells United Kingdom	7419 km	PC NEIGE LYO 10D	$16.35
Glengarry Cheesemaking	Lancaster, ON, Canada	11 652 km	PC NEIGE LYO 10D	$9.75
Trishul Trade Links	Kathmandu, Nepal	0 km	SWING FD PCA-1/10U	??

*Ajay Sarawagi of Trishul Trade Links, my contact in Nepal, never got back to me with the final price of what his company distributes the cultures for.

Conclusion

Exporting *Penicillium candidum* starter bacterial cultures from Canada to Nepal has both advantages and disadvantages. It will benefit Canada's trade relations with Nepal, but because of the low monetary value of the product, it will not benefit Canada's export market greatly nor will adding Nepal to Danlac's cliental be enough to warrant hiring more Canadian employees (E. Kinloch, personal communication, October 17, 2016). Increasing cheese production will generate more money in Nepal's local economy, especially when marketed to Western tourists who pay high prices for good quality products (Yonzon and Hunter, 1991), but increasing the herd size to produce more milk will have detrimental effects on the Nepal's landscape. Having a direct distributor in Nepal will impact Canada's ability to economically send cultures to Nepal for a cheaper price than what they are currently buying them for.

In the future, the benefits from cheese making will be highest if individual entrepreneurs decide to start up a new business just as Francois Driard has done in the Himalayas. These new businesses will need milk suppliers and factory workers to produce the cheese that will be marketed to Western tourists. Without these startup businesses, simply adding one more type of cheese to the production list in pre-existing

DDC cheese factories will not make Canadian export economical for either the Canadian company or the Nepalese people.

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