

ABSTRACT

Last Easter, our teacher and two 5th year students travelled to rural Zambia on a Development Education research trip. They reported back on Zambian culture and rural agricultural practices. During their presentation they mentioned that there was a lack of pasteurisation and refrigeration facilities for preservation. They also highlighted lack of food security and the threat of malnourishment and poverty related illnesses such as TB and HIV and AIDS. Meanwhile in the EU there was an on-going debate about the banning of raw milk ¹ and the potential health issues surrounding the consumption of raw milk. We got thinking about those people in rural Sub-Saharan Africa who consume raw milk and at times sour, as a source of nutrition. These people are living with the threat of becoming ill from bacteria such as *Escherichia Coli*, *Staphylococcus Aureus*, *Listeria*, *Tuberculosis* and *Brucellosis* amongst others^{2,3}. We wanted to come up with a sustainable strategy to preserve milk in rural communities. Initially we came up with the idea of using honey, and later, propolis (due to their anti-bacterial properties⁴) to extend the shelf-life of the raw milk in rural Africa.

First we conducted an experiment to see the growth of bacteria in both raw and pasteurised milk using nutrient agar plates. We replicated Irish conditions (i.e. pasteurisation and refrigeration) and simulated rural African conditions (i.e. no pasteurisation nor refrigeration) to monitor effects of temperature and pasteurisation on bacterial growth. We discovered that pasteurisation and refrigeration shows no growth if bacteria and bacterial growth is lessened at early stages in African conditions. On the other hand, the raw milk grows more colonies of bacteria at the two temperatures at a quicker rate. The most bacterial growth was found on the raw milk at simulated African temperatures.

Next we contacted the Irish Beekeeping Association and spoke to bee-keepers to find out how bees make honey and propolis. We sourced both of these products unprocessed from the bee-keepers in order to replicate conditions in Africa. We visited our local Institute of Technology to use their microbiology laboratory to investigate the use of honey, propolis and antibiotics on the inhibition of bacteria growth in pasteurised and raw milk. All three substances had zones of inhibition in the raw and pasteurised milk due to their anti-bacterial properties. This meant that our hypothesis was verified and further analysis was needed.

In the school laboratory we investigated the effect of honey and propolis on the pH of raw and pasteurised milk at simulated ambient African temperatures using a datalogger connected to a pH and a temperature probe. Lactic acid levels increase as milk spoils and therefore reduces the pH until it sours at pH 4.4. We used 1 ml, 2 ml and 3 ml of honey and 3 small pieces of propolis in 100 ml of raw and pasteurised milk respectively. 100 ml of each type of milk acted as a control. All 10 samples were sealed with parafilm and placed in a water bath at 24°C (temperature of shade in Africa). After 4 days we

analysed the data recorded on the datalogger. We discovered that the 2 ml honey was the most successful in preserving 100 ml of pasteurised milk. The 1 ml honey was most successful in preserving 100 ml of raw milk suggesting a more dilute solution of milk and honey is most effectively preserved. The shelf-life of the milk was extended by 16 hours compared with the control. In sub-Saharan Africa where refrigeration is rare any extension of shelf life would be very beneficial. Propolis did not have the same antimicrobial effects in the early stages as honey but was the most effective preservative after 36 hours suggesting that it may need more time to mix with the milk.

We used facilities in the Institute of Technology in Carlow to investigate the inhibition of bacteria growth on two cultures of common bacteria found in milk, *Escherichia coli* and *Staphylococcus Aureus*. We tested the antibacterial effect of both honey and propolis in pure cultures and of 1: 10 diluted (to replicated the amount in milk samples) cultures of both bacteria on agar plates. Our results show that after a 24 hour period, honey showed good inhibition of growth on pure strains of both bacteria and a larger zone of inhibition on the diluted strains. Propolis did not inhibit the growth of both types of bacteria. This may have been due to external bacterial contamination or the size of the piece of propolis used.

We conducted an effective milk quality test using the Resazurin Reduction Method. 1 ml, 2 ml and 3 ml of honey and a 3 small pieces of propolis were each placed into 100ml of raw milk respectively. This was repeated for pasteurised milk. We recorded the initial quality of both samples of milk and this showed that raw milk was of slightly less quality than pasteurised milk, therefore active micro-organisms were present in raw milk. We monitored the quality of milk after 24 hours. Our results show that the quality of the raw milk and pasteurised milk was improved but in all cases with honey and a slight improvement compared with the control for propolis.

Our results have shown that honey is very effective at preserving raw milk for short periods of time at ambient African shade temperatures. Propolis has shown strong anti-bacterial properties during initial testing and further testing is needed on the best extraction method and mixing with milk. As milk is consumed quickly after production this extension is very beneficial for rural African communities. Milk that has not undergone souring is an absolute luxury to most families.

Preserving milk with the use of honey and propolis has the potential to mitigate the effects of poverty in rural Africa. The production of milk and honey brings income to families as they can sell both products individually as well as by-products such as beeswax and royal jelly. Combining these food stuffs as we have proven will extend the shelf life of the milk improving nutrition and food security among rural communities. We propose that dairy farmers in Africa would be trained in correct milking practices and extraction of propolis from hives to reduce the contamination of milk by external bacteria therefore preventing illness. Farmers should be provided with the knowledge that 1 teaspoon of honey in half a litre of milk will preserve the milk up to 16 hours longer and that lining the milk container with honey will cut down on the growth of bacteria in the storage vessel.

We suggest that honey and milk produced on small scale production sites should seek initial funding from micro-finance institutions in their region to build up stock. This would ensure that rural communities have increased income and food security. It also fulfils sustainable agriculture practices and enhances crop production by utilising bee pollination.

The UN AIDS report 2011 stated that Sub-Saharan Africa is more heavily affected by HIV/AIDS than any other region in the world. Milk is highly nutritious food and provides protein, fat, vitamins and important minerals such as selenium. The availability of nutrient rich foodstuffs like this reduces the progression of AIDS in HIV positive patients and improves the effect of anti-retroviral (ARV) drugs⁵. Using honey or propolis in milk not only increases the shelf life of milk but also provides therapeutic treatment for HIV and AIDS patients. It provides patients with natural antibiotic properties which help to fight opportunistic infection and build immunity. Milk preserved with honey and propolis ensures that more people are provided with this essential nutrition without the adverse effects from spoilt milk.

Improved milk and propolis consumption amongst children of mothers who test positive for HIV reduces the chances of Mother to Child Transmission (MTCT) of the HIV virus. Honey should not be used with children under the age of 1 due to a spore in the honey, the risk of illness outweighs the risk of contracting HIV.

In conclusion the strategy we have outlined will improve the quality of life of those living in rural sub Saharan Africa. Our idea will mitigate not only the effects of poverty but also the millions of people living with HIV and AIDS.