Innovative reduction of postharvest losses of camel milk using magnetic refrigeration technology for improved household food security among pastoral communities of north eastern Kenya

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1. Introduction

- Improving energy efficiency, minimization of energy consumption, reducing the ozone layer depletion and global warming is the target of developing countries today.
- The north eastern part of Kenya is characterized by dry conditions leading to low production of food and especially the livelihood as camel milk as the main source of protein and income (Elhadi et al., 2015).
- Camels, unlike other livestock species, can produce milk in drought conditions and thus represent a climate adapted animal that remains a milk production resource (Morton et al., 1984).
- Women are the main actors in camel milk handling and distribution, hence more empowered. Animal diseases and unsafe animal food products affect markets, trade, economy and public health at farm and national levels (Rich et al., 2011). Traditionally camel milk is consumed raw by pastoralists and this increases potential of transmission of zoonotic diseases (Amenu et al., 2019).

2. Objectives

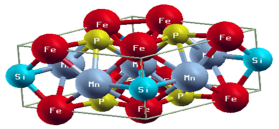
- Sensitize and engage stakeholders in standard food safety and quality procedures along the camel milk value chain.
- To contribute to income generation, reduced poverty and public health risks, improved nutrition security and livelihoods of pastoral communities.
- Corroborate the existing technologies, innovations and management practices (TIMPS) and identifying stakeholders in camel milk value chain.

3. Methods

Being a Physicist, I intend to incorporate other women from agriculture and food science. We will provide scientific knowledge regarding agriculture and food systems. We will include computational physics in collection of data. We will visit at least 100 families in NE Kenya.. Density functional theory (DFT) as implemented within the plane-wave self-consistent code quantum ESPRESSO will be used for all the calculations in this research. The exchange-correlation approximation within the DFT formalism will be carried out using the local density approximation (LDA) as parameterized by Perdew-Wang. The nuclei core's effect on the system will be analyzed using norm conserving pseudo potentials. Knowledge mobilization centres will be created but this will be with the help of women groups and associations , that is, Tawakal camel milk women group and Anolei women dairy camel marketing cooperative society.

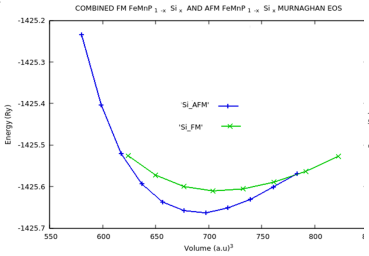
4. Results

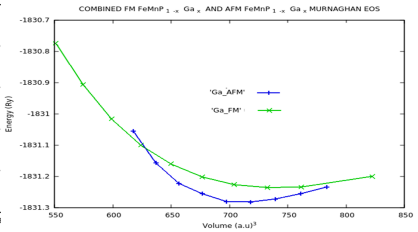
But $FeMnP_{1-x}Si_x$ has weak mechanical stability along the phase transition.
A good magnetocaloric compound required to be mechanically stable. There is needs to alloy and replace Si atoms with other viable elements. In this research, we replace Si with Ga.



Crystal structure of $FeMnP_{0.66}Si_{0.33}$ showing Fe and Mn on 3f and 3g sites, P and Si on 2c and 1b sites respectively.

$FeMnP_{1-x}Si_x$ alloy has poor mechanical stability across the phase transition. The poor mechanical stability in $FeMnP_{1-x}Si_x$ alloy leads to difficulty in repeated magnetic and thermal cycles resulting in high thermal hysteresis (Hoglin et al., 2015).





$FeMnP_{1-x}Ga_x$ alloy has better mechanical stability across the phase transition than $FeMnP_{1-x}Si_x$ alloy. $FeMnP_{1-x}Ga_x$ alloy has good repeated magnetic and thermal cycles resulting in low thermal hysteresis. Since magnetocaloric alloy works in a repeated mechanical cycle of magnetization and demagnetization process, a low thermal hysteresis of an alloys across phase transition is required (Ma et al., 2017).

5. Discussion (SDGs relevance)

This research is connected to the Strategic/Sustainable Development Goals of the United Nations (UN-SDG) in that;

- The temperatures in pastoral regions (North Eastern part of Kenya) go as high as 35 – 45 ^{0}C. This high temperature causes food spoilage due to microbial multiplication therefore, low nutrition and loss of food. After milking, the camel milk temperature should be reduced to 4 ^{0}C, or else, milk degradation through microbial breakdown will take place. Magnetic refrigeration has a higher cooling efficiency, low energy consumption, more compact and environmentally friendly when compared with vapor-compression refrigeration. This technology makes sure there is no loss of food and also the high nutritional value of the food is maintained. Therefore this technology achieves Goal 2 (Zero hunger) and Goal 3 (Good health and well being). In this research, women are the main actors in camel milk handling, distribution and the majority of actors in the camel milk value chain. This brings gender equality and therefore achieving Goal 5 (Gender equality). In this research, knowledge mobilization will be done by women groups and associations, that is, Tawakal camel milk women group and Anolei women dairy camel marketing cooperative society. This brings about partnerships and therefore achieving Goal 17 (Partnerships to achieve the goal).

6. References

- Elhadi, Y. A., Nyariki, D. M., & Wasonga, O. V. (2015) Role of camel milk in pastoral livelihoods in Kenya: contribution to house hold diet and income. *Pastoralism: Research, policy and practice*, 5, 1-8.
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7. Future computational work

- Phonon and elastic properties of $FeMnP_{1-x}A_x$ (A_x=Si, Ga) alloys must also be studied in order to determine the thermal conductivity of these alloys.

8. Acknowledgement

I would like to acknowledge the Kenya Education Network (KENET) and the Organization for Women in Science for the Developing World (OWSD) for funding my project and providing adequate resources. I am very appreciative of the efforts of Anne Thirika, Vincent Otieno and Gabriel Chirchir for their

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- Camels, unlike other livestock species, can produce milk in drought conditions and thus represent a climate adapted animal that remains a milk production resource (Morton et al., 1984).
- Post-harvest losses of about 59% of total milk produced negatively affect income of herders and health of consumers (Akweya et al., 2012).
- Women are the main actors in camel milk handling and distribution, hence more empowered. Animal diseases and unsafe animal food products affect markets, trade, economy and public health at farm and national levels (Rich et al., 2011).
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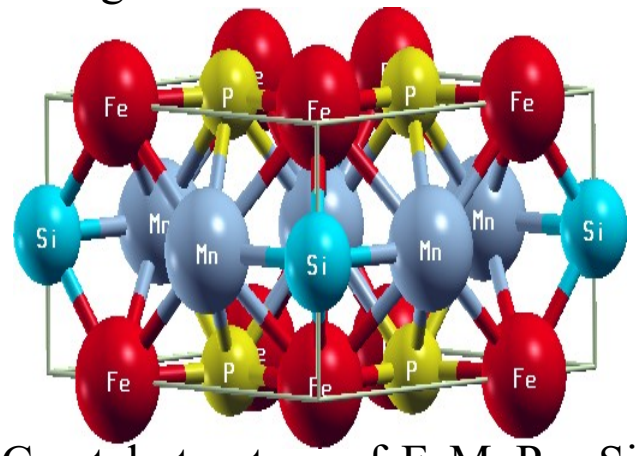
Results

The FeMn-based magnetocaloric compound of the form $FeMnP_{1-x}A_x$ (A = Ga) with hexagonal Fe_2 P- type structure is shown in the figure below.



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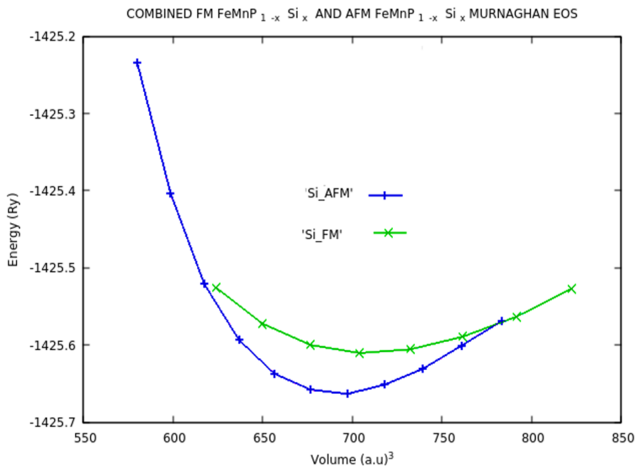

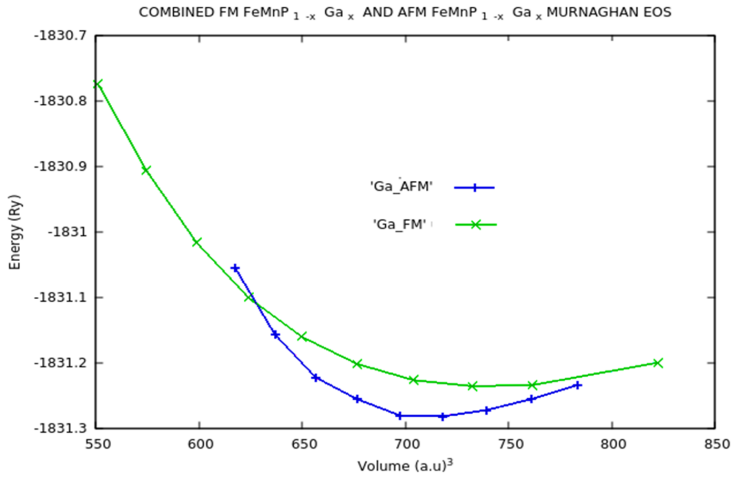

In this work;

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Future computational work

- Phonon and elastic properties of $FeMnP_{1-x}A_x$ (A_x=Si, Ga) alloys must also be studied in order to determine the thermal conductivity of these alloys.
- More funding should be put in magnetic refrigeration technology in order to achieve one of the big four agenda in Kenya which the food security.

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Thank you