Pollution Prevention in Designing the Process for Bonbon Bouye

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Montana Pollution Prevention Internship Report

Introduction

Bonbon Bouye is a peanut nutrition bar that was developed by the Montana State Food Product Development Lab in collaboration with Senegalese smallholder women farmers as a value-added food product that incorporates ingredients indigenous to Senegal. Currently the Montana State Food Product Development Lab is commercializing the product in the United States. The ingredients include a cowpea-corn flour blend, dried saskatoon berries, and multiple others that give the nutrition bar a unique taste. One key part of commercialization is the scale up process where batches go from being "benchtop" size to full production size. This scale-up process usually has many wastes and will be the target of this pollution prevention report. The goal of the internship was to design a process to produce Bonbon Bouye that included as few wastes as possible. The process steps targeted to eliminate wastes were ingredient sourcing, and saskatoon berry dehydrating.

1. Ingredient Sourcing

Finding ingredients that are right for a product is a big step in any production; however, receiving ingredients can be a large cause of emissions. The idea for sourcing ingredients was to find a supplier as close to the production facility as possible. If this can happen, then shipping emissions can drastically be minimized. Unfortunately for this process, many ingredients are indigenous to Senegal and do not grow in Montana, some not even in the United States. For sourcing I specifically looked at cowpea and corn flour, as these ingredients combine to make 31% of the nutrition bar. Luckily, corn is grown in Montana, and a supplier was found that is only 215 miles from the production facility, which is over twice as good as the closest alternative at 521 miles. This saves 306 miles, which means the green house gasses are reduced by 0.110 metric tons of CO_2 equivalent ($MTCO_2e$). Over the course of a year with a shipment every month, 1.32 $MTCO_2e$ is saved from being emitted. Cowpea flour was more difficult to find a good supplier. Ultimately it was decided to buy whole cowpeas and mill them as part of the process. This not only saves emissions, but money as well, as cowpea flour costs $10/lb. Switching from cowpea flour to milling cowpea saves emissions because the dried cowpeas are shipped from Kentucky, where the cowpea flour is shipped from Florida. Shipping from Madisonville, Kentucky the ingredients travel 1,879 miles, whereas shipping from Opa Locka, the ingredients travel 2,868 miles. The reduction is 1,611 miles which reduces the greenhouse gasses by 0.579 $MTCO_2e$ per shipment. Over the course of a year with a shipment every month, that is 4.26 $MTCO_2e$ saved from being emitted to the atmosphere. The data is shown in Table 1 below.

Table 1: Emissions saved by reducing miles travelled of ingredients

Ingredient	Vehicle Miles Reduced	GHG Reduction per Month ($MTCO_2e$	GHG Reduction per Year ($MTCO_2e$)
Corn Flour	306	0.110	1.32
Cowpea Flour	1611	0.579	6.95

2. Saskatoon Berry Dehydrating

Drying berries can be very energy intensive. Osmotic drying, soaking berries in a sugar solution, can be used before dehydration to decrease the time the berries are in the dehydrator. When berries soak in sugar water, osmosis drives water out of the berries. Many studies have been done on many other fruits on the effects of osmotic drying, but none on saskatoons. An experiment was carried out to see if osmotic drying influenced the dehydrating time of saskatoon berries. Berries were soaked in a solution of 60 °Brix for 2, 4, and 6 hours. The berries were then placed in a cabinet along with berries that had not been soaking in a sugar solution. The water activity was checked every 2 hours. It was found that osmotic drying as a pretreatment did decrease the time the berries required in the dehydrator to reach a water activity of 0.6 (water activity of 0.6 is used to prevent mold growth). In fact, in all the cases where the berries were soaked the drying time decreased, and the most the time decreased was by 1.8 hours from soaking for 6 hours. This makes sense as soaking longer allows for more water to be drawn out of the berries by osmosis. In turn soaking the berries for 6 hours in a 60 °Brix solution would save. The data is shown in Table 2 below, and a graph of the drying time verses water activity for the control berries and the berries that soaked for 6 hours is shown in Figure 1.

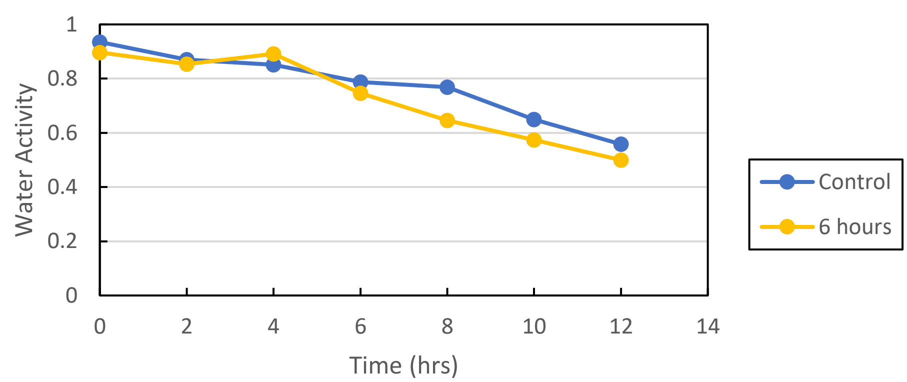

Figure 1: Water Activity of Saskatoons in a Dehydrator

Table 2: Time and Energy Difference between control berries and berries that soaked in a 60 °Brix sugar solution

	Drying Time for One Batch (hr)	Time Saved per Batch (hr)	Energy Saved per Batch (kWh)	Energy Saved per Year (kWh)	GHG saved per year (MTCO2e)
Control	11.07	--	--	--	--
60 °Brix - 2 hrs	10.11	0.96	4.6	286	0.193
60 °Brix - 4 hrs	10.7	0.37	1.8	110	0.074
60 °Brix - 6 hrs	9.27	1.8	8.6	536	0.362

Conclusion

Overall, in designing the process for Bonbon Bouye and paying close attention to factors that cause unnecessary waste, 8.632 $MTCO_2e$ of green house gasses can be eliminated. In doing so, the new process saves $6,865 when combing savings from switching to whole dried cowpeas and electricity costs. The summary of reductions and savings can be seen below in Table 3.

Table 3: Total Annual Reduction and Savings from different Solutions

	Energy Saved per Year (kWh)	GHG Reduced per Year (MTCO2e)	Money Saved per Year
Ingredients	--	8.27	$6,814.30
Drying	536	0.362	$51.13
Total	536	8.632	$6,865.43