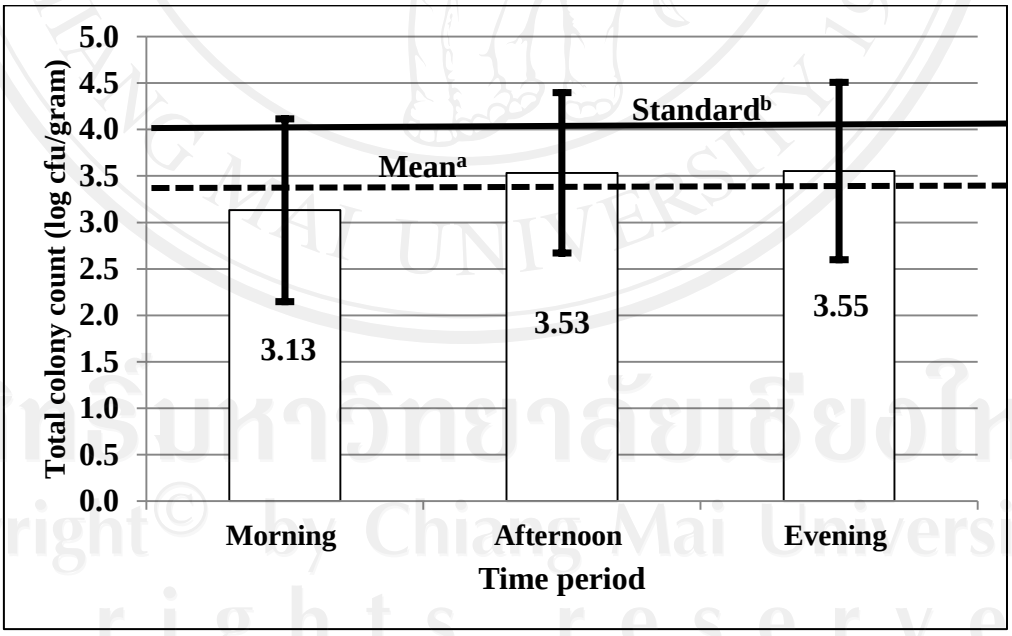
CHAPTER IV

RESULTS

4.1 Total colony count and total yeast and mold in Northern Thai sausage

The means of total colony counts (Mean±SD) were 3.38±0.27 log cfu/g as shown in Figure 4. Means were 3.13, 3.53, and 3.55 log cfu/gram for morning, afternoon, and evening samples, respectively. The total colony count log number were not significantly difference amoung shops.

Figure 4: Mean values (mean±SD) for total colony counts of Northern Thai sausage by sampling time

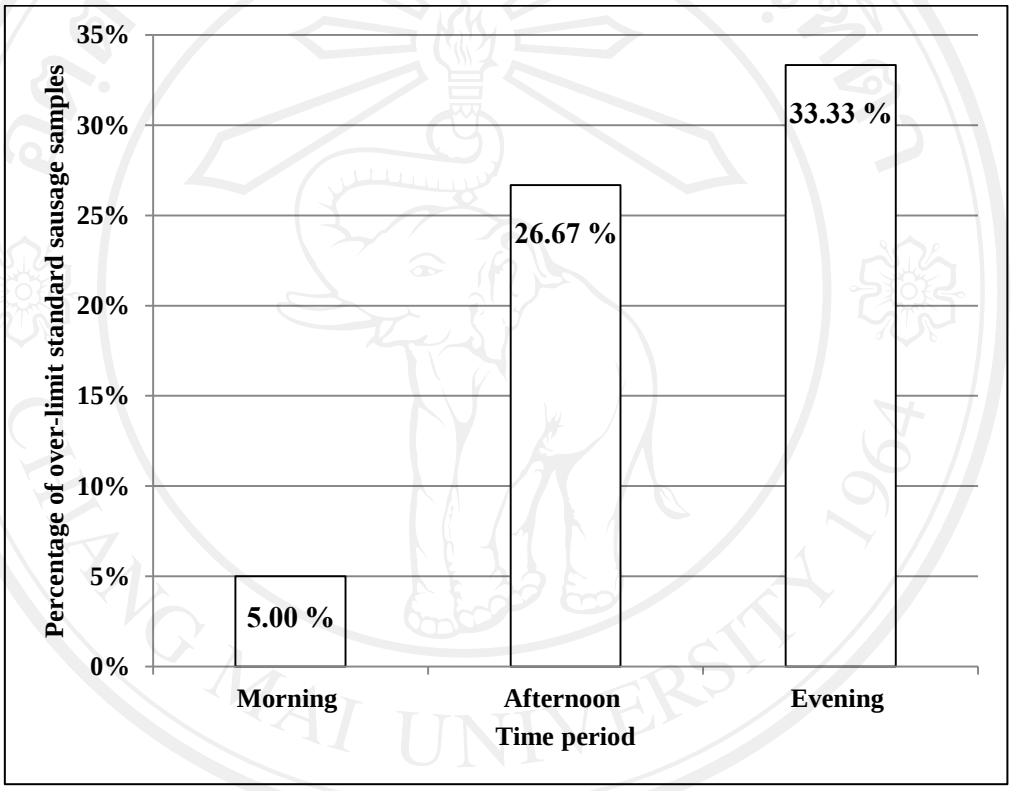


[a] Grand total mean of total colony count for all sausage samples

[b] Thailand community product standard criteria (not more than 4 log cfu/gram)

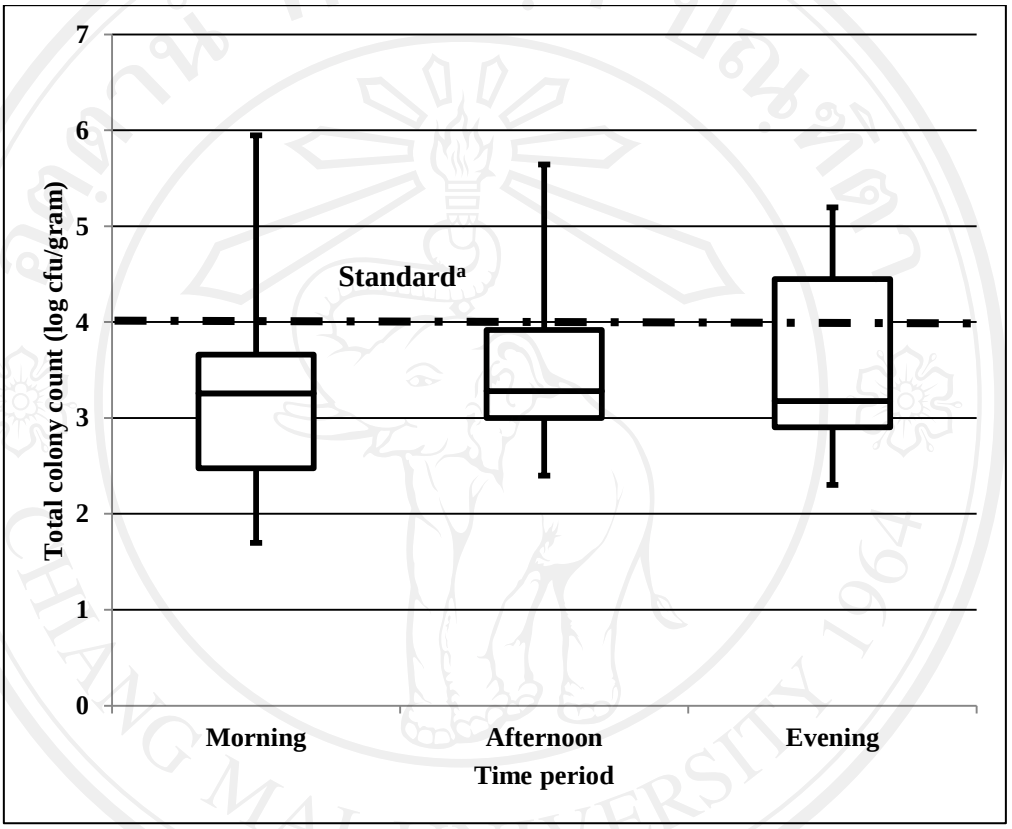
For the three collection time periods, the percentage of sausage samples which achieved the standard were 5%, 26.67% and 33.33%, respectively. The data are shown in Figure 5.

Figure 5: Percentage of sausage samples which achieved the standard in each time period for total colony count



The average total colony counts were not significantly different among the different collection times period groups ($p<0.05$). The data are shown in Figure 6.

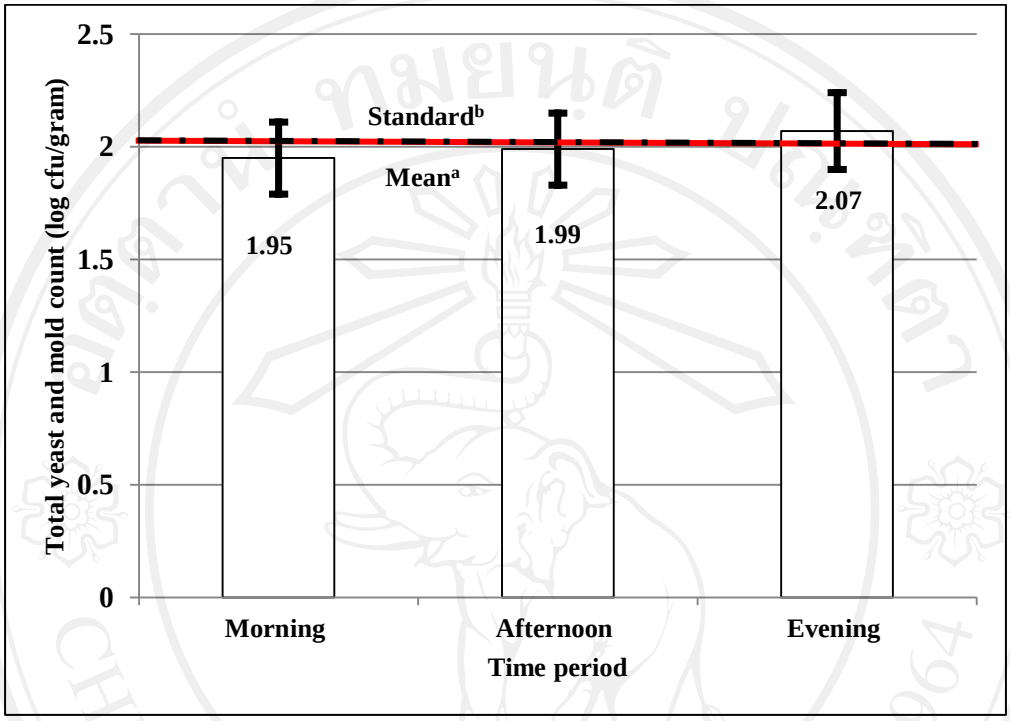
Figure 6: Comparison of total colony count in each time period



[a] Thailand community product standard criteria (not more than 4 logcfu/gram)

The means of total colony count and yeast and mold (Mean±SD) were 2.00±0.31 log cfu/gram. As shown in Figure 7, the time period groups means were 1.95, 1.99 and 2.07 log cfu/gram for the morning, afternoon and evening groups, respectively. The total yeast and mol count log numbers were not significantly difference amoung shop**.**

Figure 7: Mean values (mean±SD) for total yeast and mold counts of Northern Thai sausage by sampling time

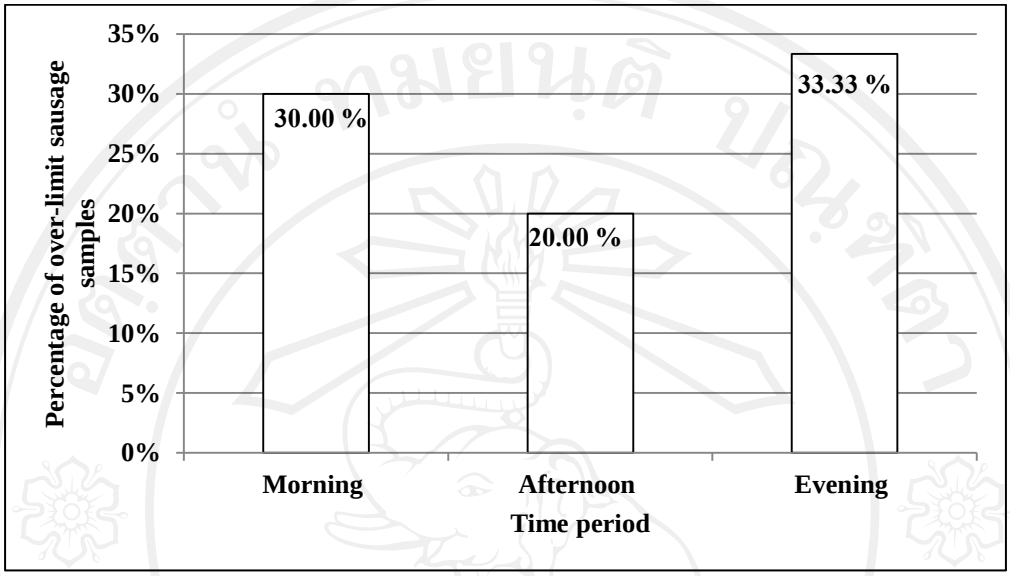


[a] Grand total mean of total yeast and mold count for all sausage samples

[b] Thailand community product standard criteria (not more than 2 log cfu/gram)

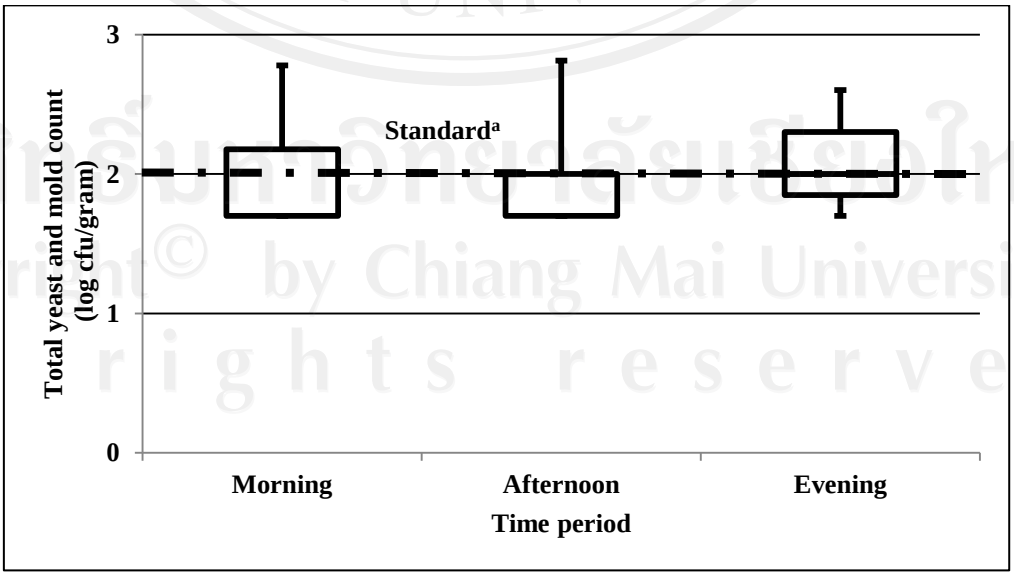
In each of the collection time periods, the percentage of sausage samples which achieved the standard for total yeast and mold count were 5%, 26.67%, and 33.33%, respectively. The data are shown in Figure 8

Figure 8: Percentage of sausage samples which achieved the standard in each time period for total yeast and mold count



The averages of total colony count were not significantly different among different collection times period groups ($p<0.05$). The data are shown in Figure 9.

Figure 9: Comparison of total yeast and mold count in each time period



[a]Thailand community product standard criteria (not more than 2 log cfu/gram)

4.2 Miocrobiological results on *Escherichia coli Salmonella* spp., *Staphylococcus aureus*, and *Clostridium perfringens*

All of the sample founded that *Escherichia coli* was less than 0.3 MPN/gram. One sample from the afternoon collection period contained *Staphylococcus aureus* (2%), whereas one sample from the morning group was positive for *Clostridium perfringens* (2%). *Salmonella* spp. was not detected in this study. The microbiological results in each time period is showed in the table 12.

Table 12: Number of met and not met standard limit samples by sampling time

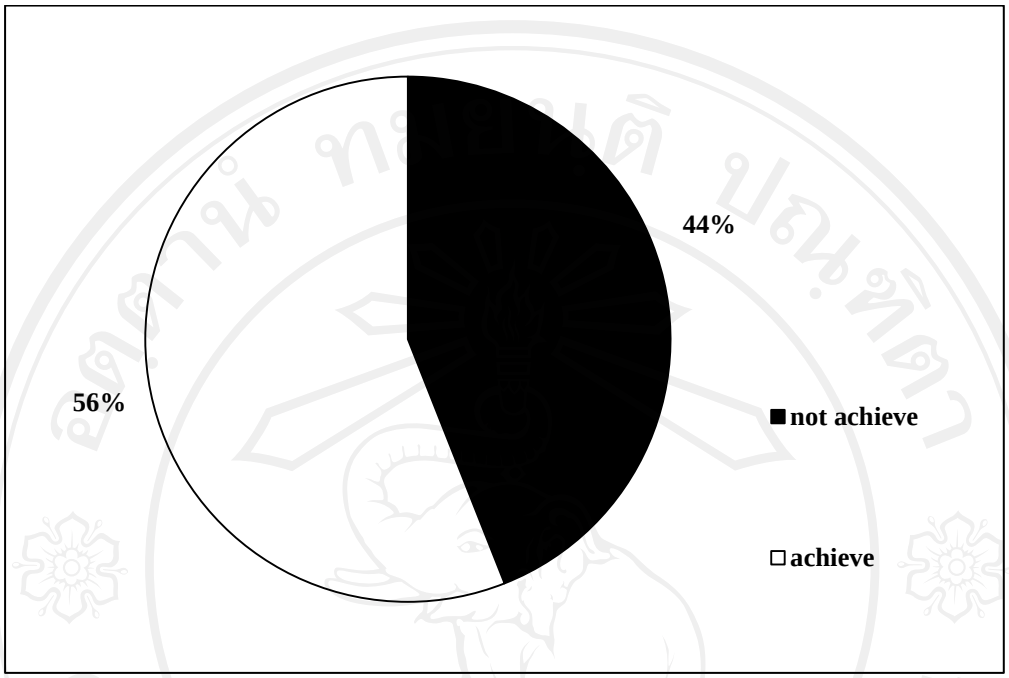
Microorganisms	Time periods					
	Morning(n=20)		Afternoon(n=15)		Evening(n=15)	
	Not met[a]	Met[b]	Not met[a]	Met[b]	Not met[a]	Met[b]
***Salmonella* spp.**	**0**	**20**	**0**	**15**	**0**	**15**
Escherichia coli	**0**	**20**	**0**	**15**	**0**	**15**
Staphylococcus aureus	**0**	**20**	**1**	**14**	**0**	**15**
Clostridium perfringens	**1**	**19**	**0**	**15**	**0**	**15**

[a,b]Thai community product standard criteria 294/2004

4.3 Microbiological profile of Northern Thai sausage compared with the Thai Commuity Product Standard criteria 294/2004

Eighty percent of sausage samples were within the acceptable range of the standard for total colony count. Seventy two percent of sausage samples achieved the standard for total yeast and mold count. All the sausage samples achieved the standard for *Escherlichia coli* and *Salmonella* spp. Ninety-eight percent of the sausage samples achieved the standard for *Clostridium perfringens* and 98% of sausage samples met the standard for *Staphylococcus aureus*. The percentage of sausage samples which met all the standard criteria was 56% as shown in Figure 10.

Figure 10: Percentage of Northern Thai sausage which met all standards criteria



4.4 Growth factor observation results

The growth factors means were shown in the table 13

Table 13: Bacterial growth factors by collection time (Mean±SD)

Time period	Mean of Temperature (°C)	Mean of a_w	Mean of pH
Morning	**42.45±21.26**	**0.968±0.005**	**6.33±0.44**
Afternoon	**37.93±11.21**	**0.975±0.006**	**6.08±0.68**
Evening	**30.06±2.49**	**0.965±0.014**	**6.24±0.22**
Grand Total	**37.37±15.47**	**0.969±0.010**	**6.23±0.49**

4.4.1 Temperature

Internal temperatures were not significantly different between different collection time periods ($p>0.05$). The range of temperature in the morning was the

most variable. The range of temperature in evening was between 20-30^{0}C. The comparing of temperature by collection time were shown in figure 11.

Figure 11: Comparison of temperature by collection time periods

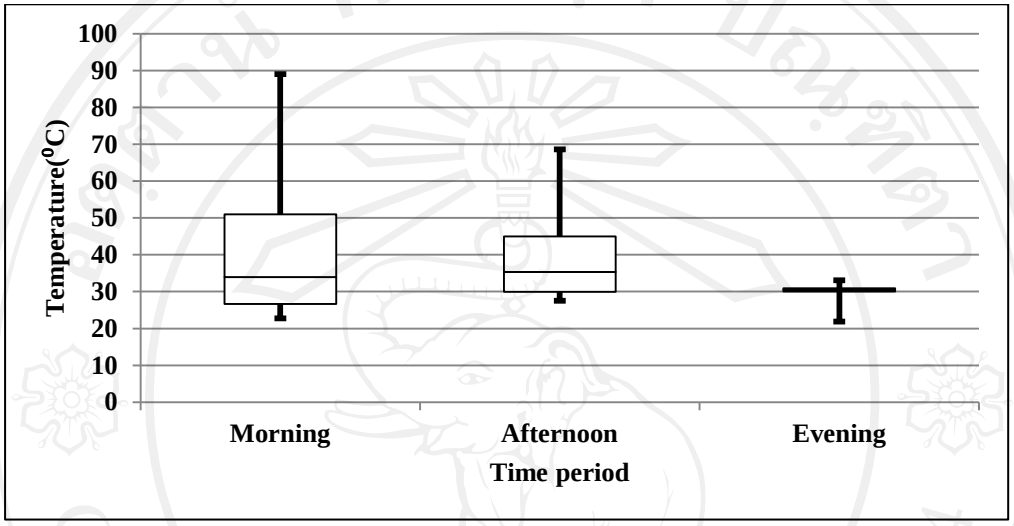


Figure 12 show the mean of Northern Thai sausage temperature comparing with the growth range of each microorganism. The temperature were in the same range of microorganism in the previous study (Adams and Moss, 2008). In figure 13., for *Staphylococcus aureus*, the temperature were in the same range as the growth range of the microorganism (7^{0}C-48.7^{0}C) and their enterotoxin production temperature range (35^{0}C-40^{0}C) (Adams and Moss, 2008).

Figure 12: Comparison of average sausage internal temperature ranges with the growth range of each microorganism

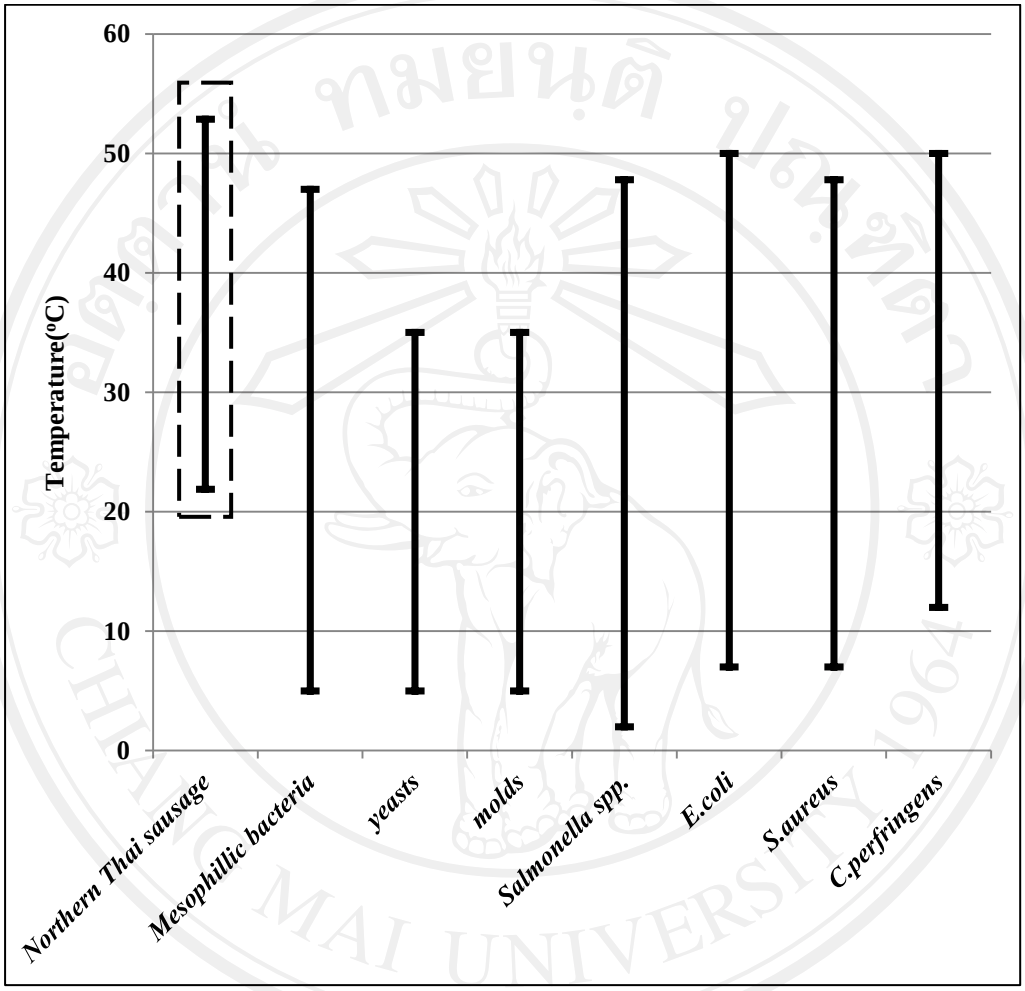
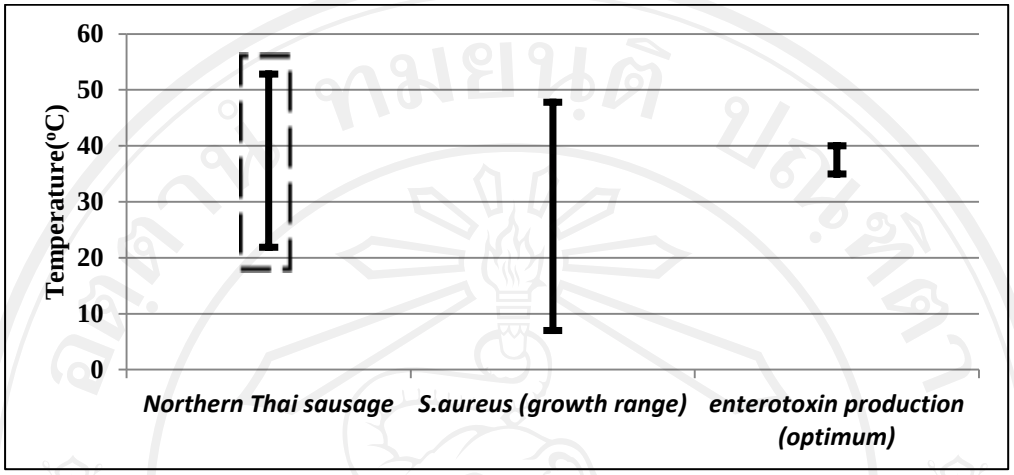
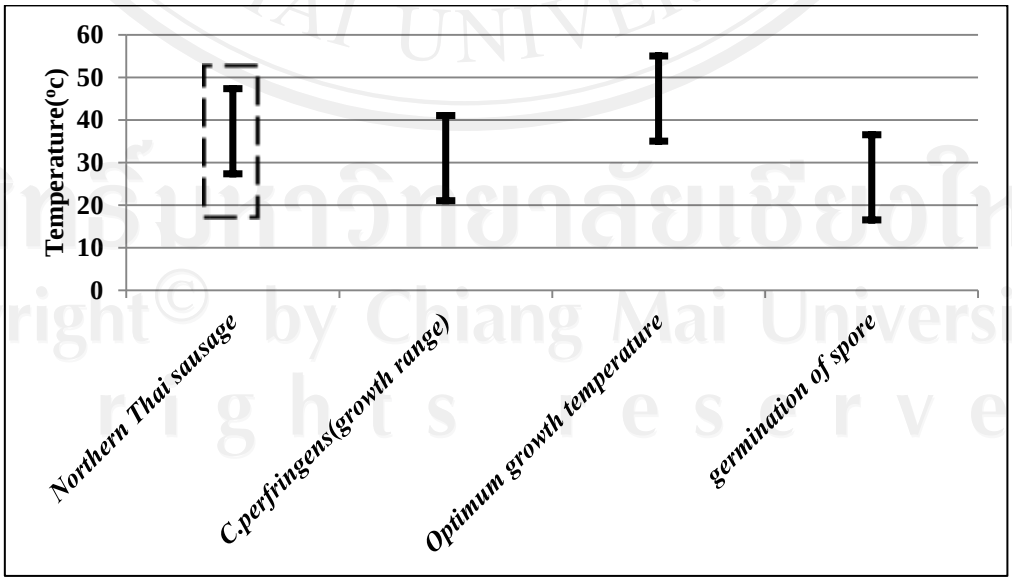


Figure 13: Comparing sausage internal temperatures mean with the growth range and the enterotoxin production range of *Staphylococcus aureus*



From figure 14, Northern Thai sausage temperature were in the same range as growth range of *Clostridium perfringens* and their spore germination temperature range (3.5^0C-50^0C) (Adams and Moss, 2008).

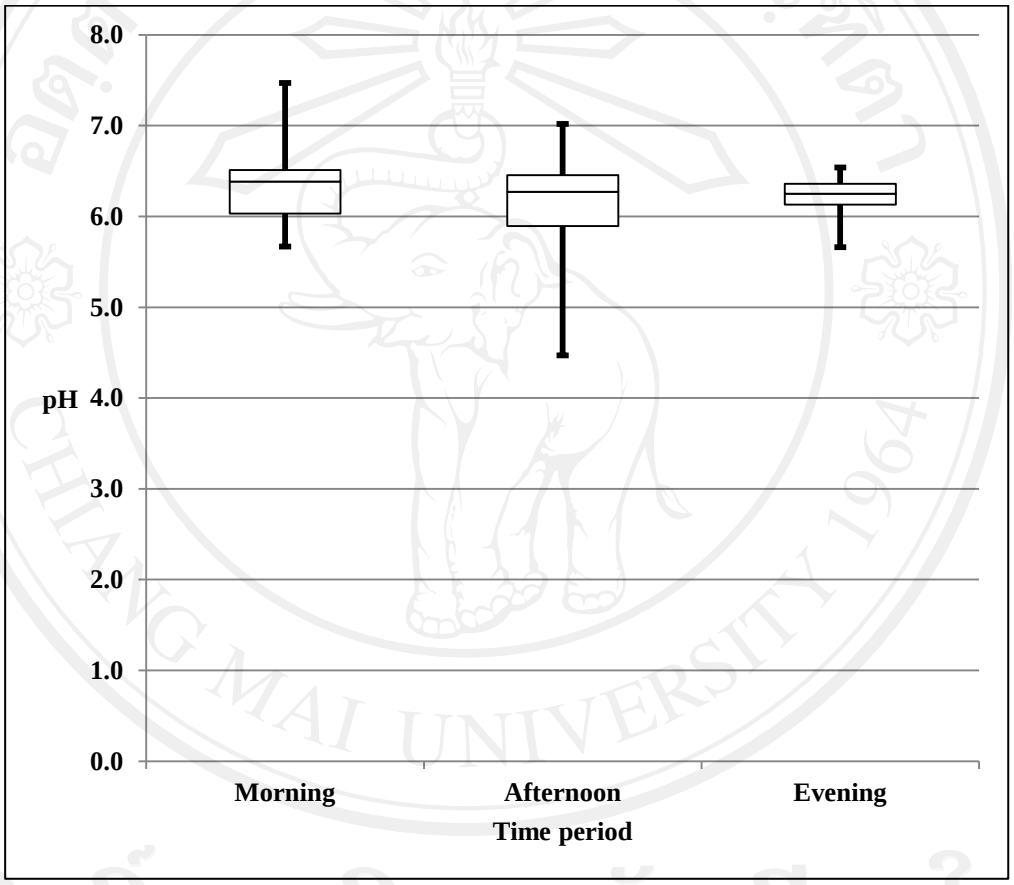
Figure 14: Comparing sausage internal temperature mean with growth range of *Clostridium perfringens* and for germination of spores



4.4.2 Acidity and alkalinity

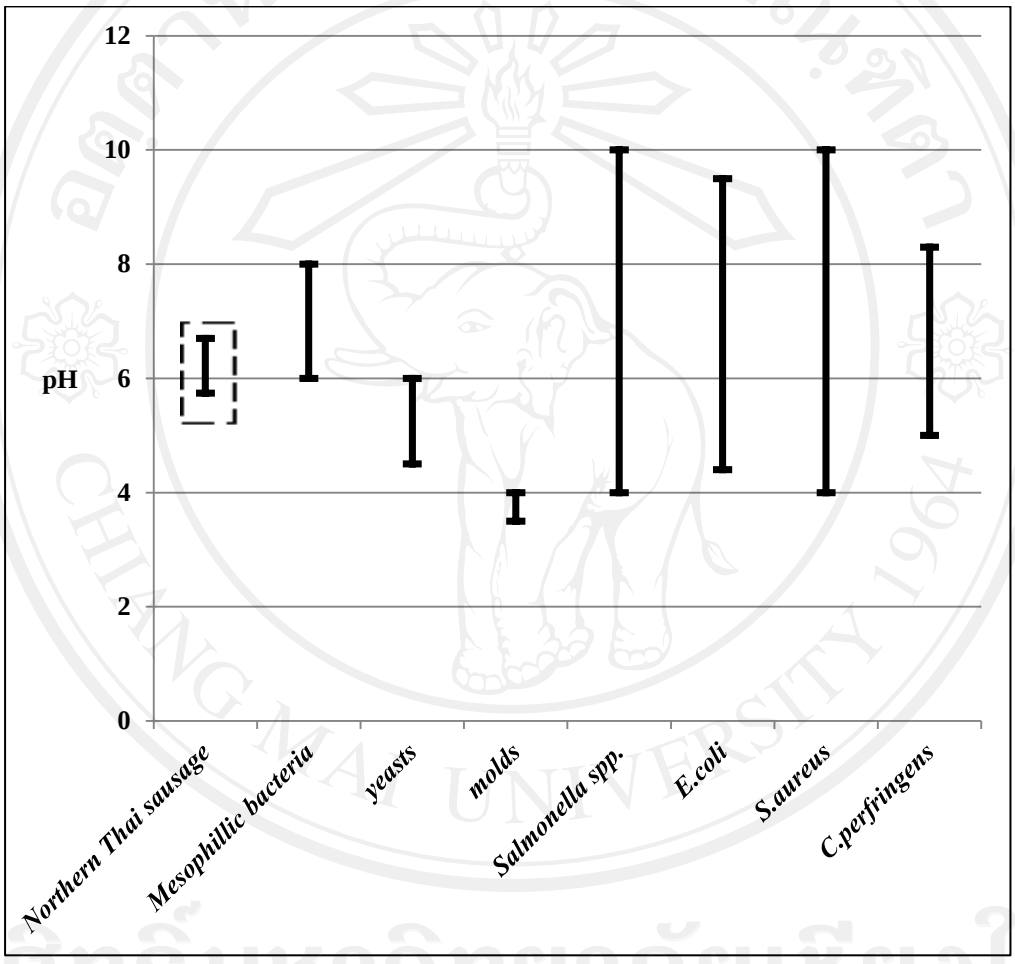
The pH values were not statistically different among collection time groups ($p>0.05$). The average pH in each collection time period was nearly neutral which supported the growth of microorganisms.

Figure 15: Comparison of pH by collection time period



From figure 16, The pH mean of Northern Thai sausage were in same ranges as growth range of most microorganisms except mold spp.

Figure 16: Comparing sausage pH mean with the growth range of microorganism



4.4.3 Water activity

Water activity was significantly different among the different collection time periods ($p<0.05$). From growth factor measurements, the water activity levels were statistically significantly different among the collection time periods. This factor needs further, repeated investigation.

Figure 17: Comparison of water activity in each collection time period

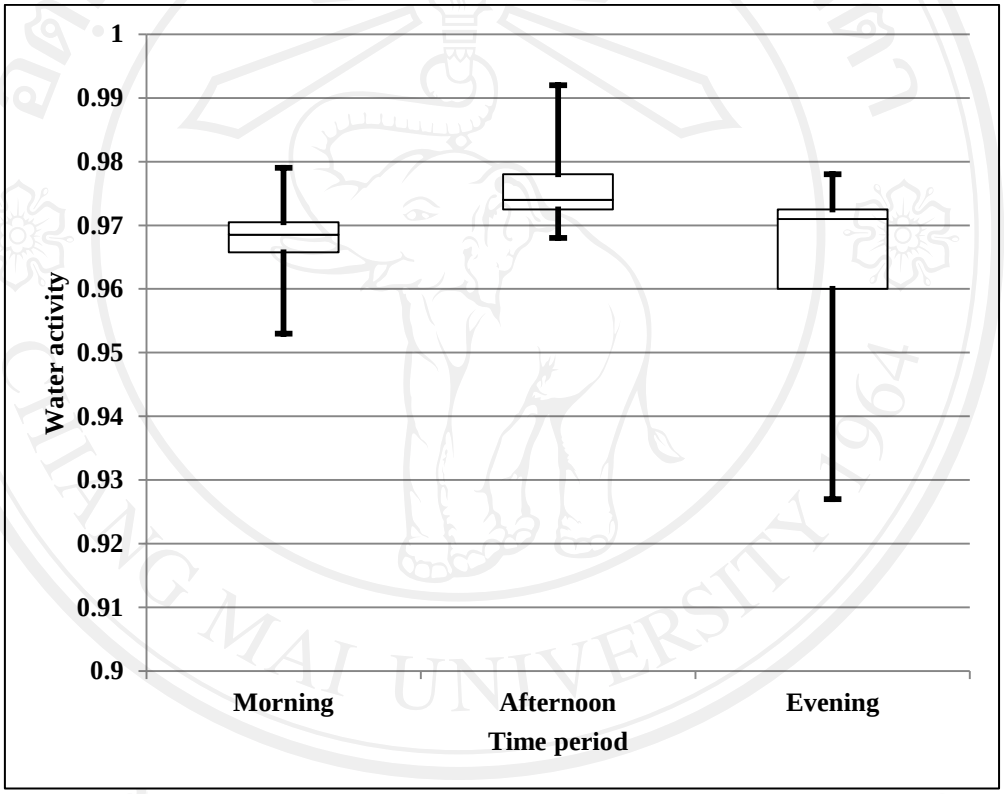
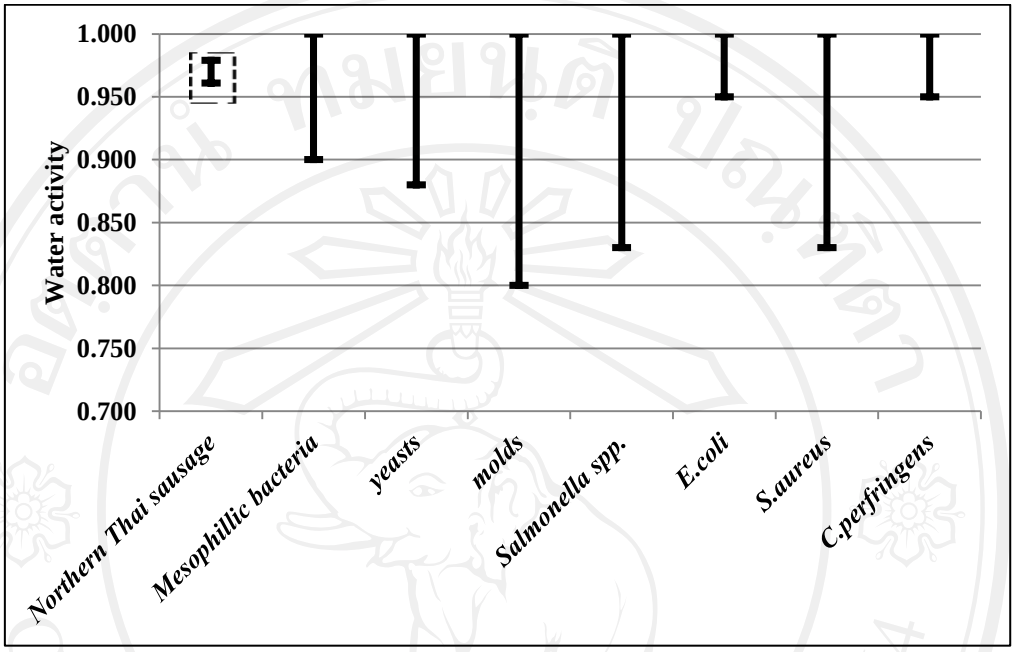


Figure 18: Comparing sausage water activity mean with the growth range of microorganism



From figure 16, Northern Thai sausage water activity mean were in the same range as growth range of microorganisms. Comparing value of temperature, wateractivty and pH with previous study, The percentage of sausages which have growth factors in the same range of microorganisms were shown in the table 14.

Table 14: Percent of samples in which study growth factors were in the same growth range of microorganisms

Microorganisms	Percentage
Mesophillic bacteria	**72.00**
Yeasts and molds	**4.00**
Escherlichia coli	**84.00**
***Salmonella* spp.**	**84.00**
Staphylococcus aureus	**86.00**
Clostridium perfringen	**83.67**