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THE INTERRELATIONSHIPS BETWEEN pH, CALCIUM CHLORIDE AND RENNET CONCENTRATIONS ON CURD YIELD

pH, KALSİYUM KLORÜR VE RENNET DERİŞİMLERİ İLE PIHTI VERİMİ ARASINDAKİ İLİŞKİ

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ABSTRACT: The objective of this study is to contribute the works on the standardization of renneting of milk and on the cheese yield. For this purpose the effects of pH, calcium chloride and rennet concentrations on the yield were determined. In this research, losses of nitrogen and solids-non-fat into the whey, actual and adjusted yields and whey release were measured. The effects of these three variables on the yield parameters were found to be significant ($p < 0.05$). This study was carried on by utilization of reconstituted skim milk and raw skim milk. It was found that the losses of protein and solids-non-fat into the whey during the renneting of raw skim milk has been higher than those of reconstituted skim milk.

ÖZET: Bu çalışmanın amacı peynir verimi ve rennetleme sürecinin standardizasyonu üzerine yürütülen araştırmalara katkıda bulunmaktır. Bu amaçla pH, kalsiyum klorür ve rennet derişiminin pıhtı verimi üzerine etkisi saptanmıştır. Bu araştırmada peynir suyuna azotlu maddeler ve yağsız kurumadde öğelerinin geçişi, gerçek ve hesaplanmış verim, ayrılan peynirsuyu miktarı ölçülmüştür. Anılan üç bağımsız değişkenin etkisinin önemli olduğu bulunmuştur. Bu çalışma yağsız taze süt ve rekonstitüe yağsız süt kullanılarak yürütülmüştür. Peynir suyuna protein ve yağsız kurumadde öğelerinin geçişini taze sütte, rekonstitüe süte göre daha yüksek olduğu saptanmıştır.

INTRODUCTION

There has been interest in relating the yield of cheese to components in milk since the last century. Yield is of basic importance to the cheese industry. Small differences in yield translate to large sums of money for cheese plants. Some authors correctly relate the yield of cheese to amount of fat and casein in milk.

Sophisticated yield formulas are used successfully to help control moisture content, cheese yield and cheese making efficiency (LAU et al., 1990). If actual yield is larger or smaller than predicted, this indicates higher or lower moisture content than is desired or legal, signaling a change in manufacturing procedure. Not all, however, advocate the use of predictive yield approaches, preferring to control cheese making by monitoring critical losses and components of curd and/or cheese (GILLES and LAWRENCE, 1985).

To estimate the effect of rennet on yield, the additional amount of protein (casein) losses into whey must first be estimated. Because the most critical component of milk for cheese making is casein.

LAU et al (1990) estimate the percentage of nitrogen recovery in each product as the weight of each product multiplied by its percentage of nitrogen content and then divided by the total weight of nitrogen in the original milk and multiplied by 100.

RESULTS AND DISCUSSIONS

For checking the changes of renneting variables on the release of whey, losses of SNF and protein into the whey, and yield of curd were tested. The figures show the individual effects and the interrelationships of the research variables on these parameters.

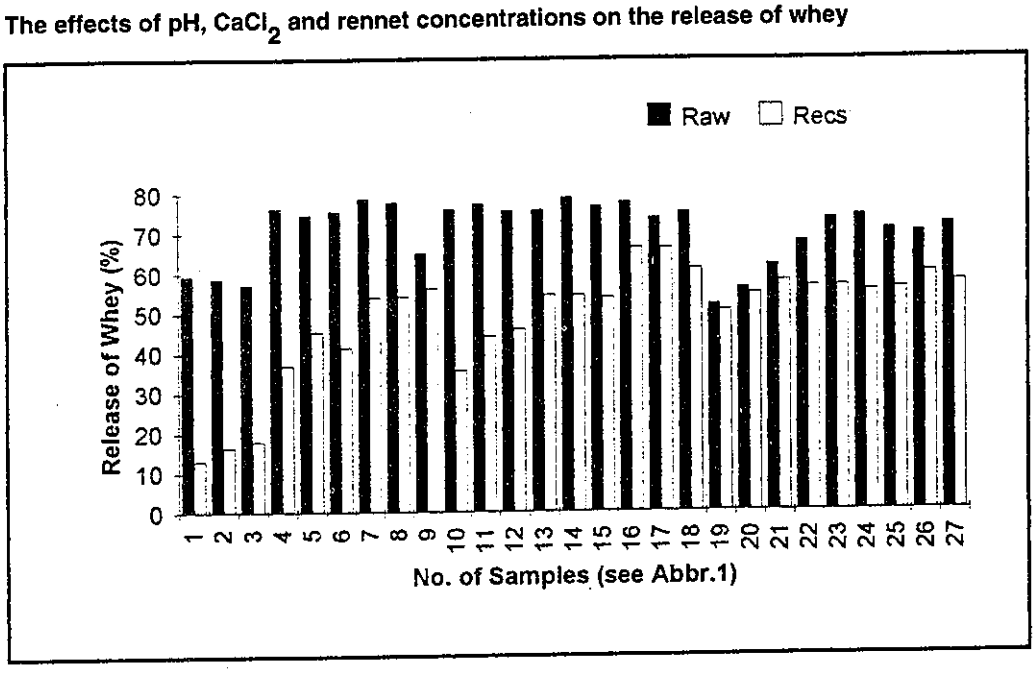

Fig. 1. The effects of pH, $CaCl_2$ and rennet concentrations on the release of whey after renneting of raw skim milk (RAW) and reconstituted skim milk (RECS) samples.

Data presented in Fig. 1 show that the release of whey of renneted skim milk samples, in a given time (60 min), were clearly greater than those of reconstituted skim milk samples. On the other hand the level of change of the whey release was found to be limited for raw skim milk gels. For all $CaCl_2$ concentrations the release of whey increased with decreasing the pH of milk. And the release increased with increasing rennet concentration at pH 6.50 and at all $CaCl_2$ concentrations in reconstituted skim milk samples. Relatively, the amount of whey released in the given time increased with decreasing pH and increasing $CaCl_2$ concentrations. The effect of rennet concentration on this parameter did not show a meaningful variation but it should be concluded with rennet clotting time.

The effects of pH, $CaCl_2$ and rennet concentrations on the losses of SNF and nitrogen

The loss of nitrogen was estimated according to LAU et al. (1990). The loss of SNF was also estimated with the same basis.

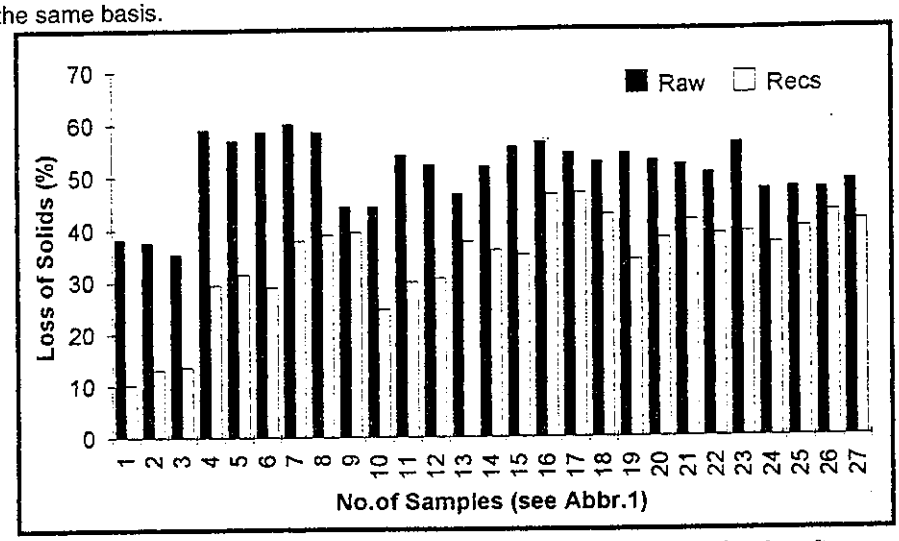

Fig. 2. The effects of pH, $CaCl_2$ and rennet concentrations on the loss of solids into the whey after renneting of raw skim milk (RAW) and reconstituted skim milk (RECS) samples.

Fig. 2 shows that the effects of the research variables on the loss of SNF into the whey. It is clears that the losses were greater for the whey of raw skim milk samples other than. And the losses of the samples at pH 6.00 were larger than the samples which were at other two pH degrees. However the loss of SNF increased with decreasing of pH at all $CaCl_2$ concentrations.

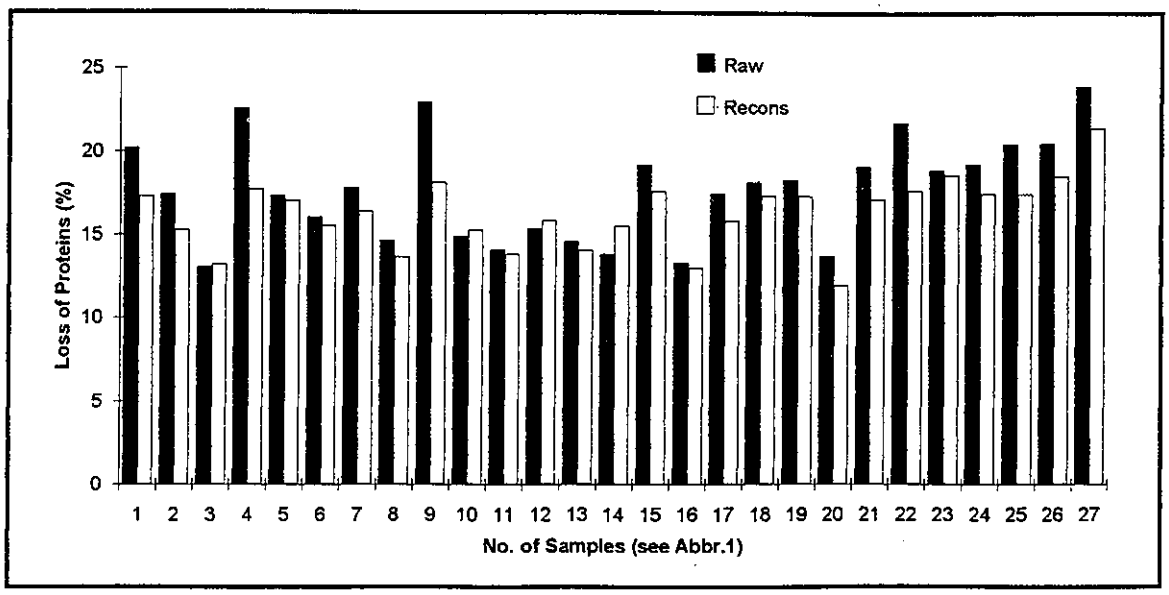

Fig. 3. The effects of pH, $CaCl_2$ and rennet concentrations on the loss of nitrogen into the whey after renneting of raw skim milk (RAW) and reconstituted skim milk (RECS) samples.

The losses has shown an increasing tendency with increasing rennet concentration at pH 6.50 for all $CaCl_2$ concentrations, but a decreasing tendency was found for other two pH degrees with increasing rennet concentrations for reconstituted skim milk samples.

Fig. 3. shows that the loss of nitrogen into the whey. The loss of nitrogen, in a given time after cutting of the curd during the ewhey release, was greater for raw skim milk samples, but differences between the samples were found to be negligible.

The nitrogen losses decreased with increasing rennet concentration at pH 6.50 and pH 6.00 at 1 mM-$CaCl_2$. The losses decreased at pH 5.50 when the rennet concentration increased two-fold while it increased when the concentration of rennet increased three-fold in same case.

Decreasing of pH from 6.50 to 6.00 has an effect on increasing the losses, but in the case of decreasing pH from 6.00 to 5.50, the loss of nitrogen decreased for all $CaCl_2$ concentrations.

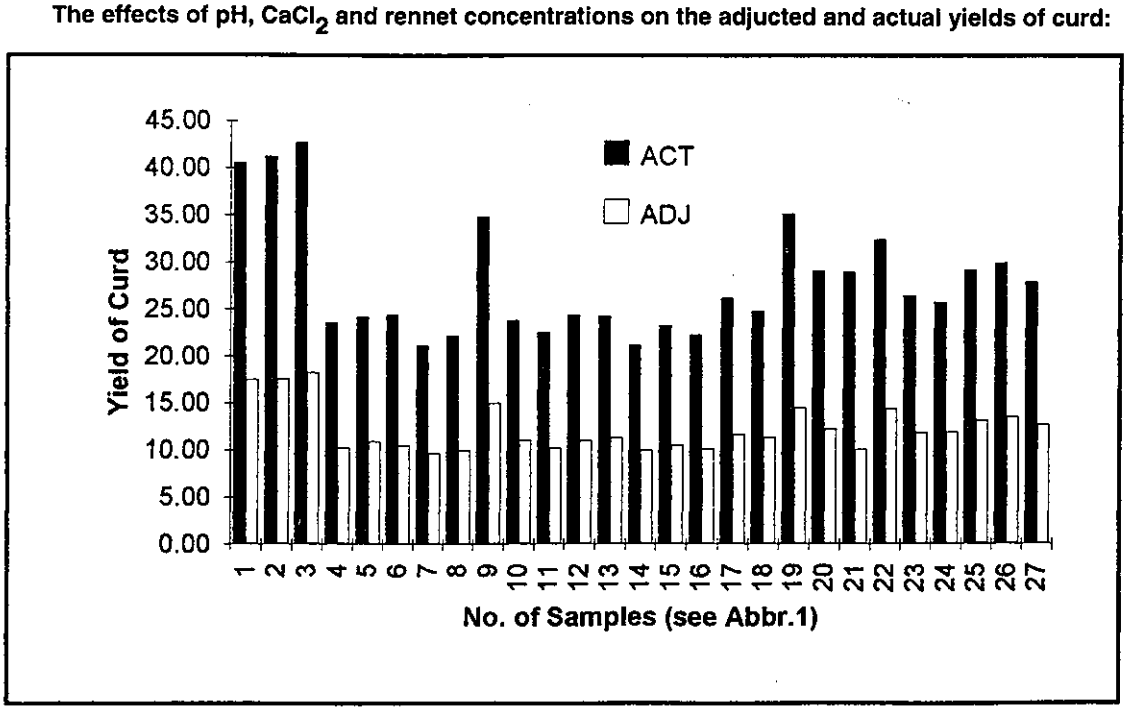

Fig 4. The effects of pH, $CaCl_2$ and rennet concentrations on the actual yield (ACT) and adjusted yield (ADW) of renneted raw skim milk curds.

It is shown from Fig. 4 and Fig.5 that the curd yield of reconstituted skim milk samples higher than of the raw skim milk. For lower $CaCl_2$ concentrations (1mM and 10 mM), actual and adjusted yields of the curd of raw skim milk increased with increasing enzyme concentration and it showed decreasing tendency with dropping of pH level for the curds of raw skim milk samples.

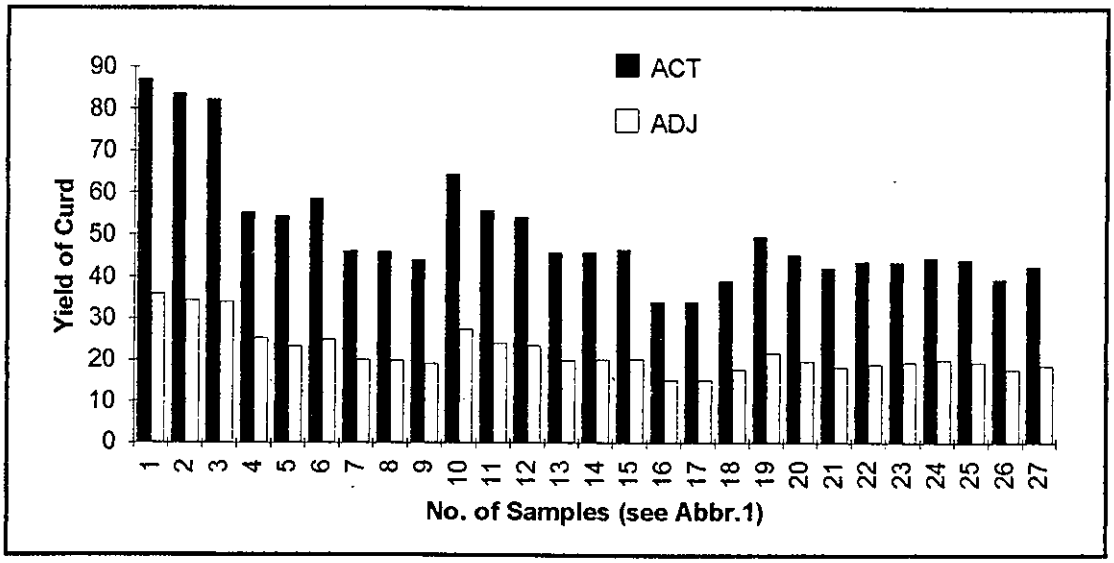

Fig. 5. The effects of pH, $CaCl_2$ and rennet concentrations on the actual yield (ACT) and adjusted yield (ADJ) of renneted reconstituted skim milk curds.

The changes of renneted reconstituted skim milk samples with research variables were gradual. Both of the yields decreased with increasing $CaCl_2$ concentration from 1 mM to 100 mM. It was also found that the yield of curd was the greatest at 1 mM-$CaCl_2$, and at pH 6.50, and at 0.4 % rennet concentration. It is probably depend on the retardation of rennet clotting time and the weight factor was to be larger than the factor related with moisture content.

It is clear that differences between the adjusted yield and actual yield of the samples were very meaningful. The effect of moisture retained in the curd caused by wet (actual) yield was not to be a good criterion, since differences in moisture content diverge the solids recovery. This observation is in agreement with the results of LAU et al. (1990) and USTONOL and HİCKS (1990).

Abbreviation 1

No. of Samples	$CaCl_2$ Con.(mM)	pH	Enzyme Con. (%)
1	6.50	0.4	
2	1	6.50	0.8
3	1	6.50	1.2
4	1	6.00	0.4
5	1	6.00	0.8
6	1	6.00	1.2
7	1	5.50	0.4
8	1	5.50	0.8
9	1	5.50	1.2
10	10	6.50	0.4
11	10	6.50	0.8
12	10	6.50	1.2
13	10	6.00	0.4
14	10	6.00	0.8
15	10	6.00	1.2
16	10	5.50	0.4
17	10	5.50	0.8
18	10	5.50	1.2
19	100	6.50	0.4
20	100	6.50	0.8
21	100	6.50	1.2
22	100	6.00	0.4
23	100	6.00	0.8
24	100	6.00	1.2
25	100	5.50	0.4
26	100	5.50	0.8
27	100	5.50	1.2

CONCLUSIONS

- It is observed that differences between the effects of renneting parameters on the curd yields of raw and reconstituted skim milks are significant ($p<0.01$).
- pH, $CaCl_2$ and rennet concentrations affect the curd yielding capacity both of individually and together.
- There are complex interrelationships between the effects of pH, $CaCl_2$ and rennet concentrations and curd yield.
- Adjusted yield of curd is more meaningful than wet yield.
- With the SNF basis, the yield of curd is decreased by increasing $CaCl_2$ concentration, decreasing pH from 6.50 to 5.50 and decreasing rennet concentration.
- The effects of $CaCl_2$ on renneting process and yield are independent from the changes of pH.
- The concentration of rennet affects the yield of curd, because of its effect on rennet clotting time.

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