EXUDATION OF WHEY FROM CHEESE DURING STORAGE

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Prabandha Kumar Samal

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ABSTRACT

Cheeses of low pH, such as Feta, Blue, Cream and Cheshire, often exude whey after manufacture. This exudation lowers the yield and reduces product acceptability. Virtually no scientific study has been undertaken on this subject. Investigations were therefore undertaken to determine the factors affecting exudation and to elucidate the underlying mechanism. Cream cheese made by the hot-pack method and recombined Feta cheese made by the traditional method, representing unripened and ripened varieties of cheese respectively, were studied.

In Cream cheese the amount of exudate increased with decreased protein to fat (P/F) ratio, decreased homogenisation pressure, decreased pasteurisation temperature, decreased pH at cooking, decreased cooking temperature, increased storage temperature and increased storage time. Within the selected limits of variation of P/F ratio, fat did not affect exudation. However, an increase of moisture in non-fat substance resulted in an increased amount of exudate. The effect of homogenisation pressure appears to be due to the increase in the fat globule surface area and the increase in the coating of fat globule with casein. The partial heat-denaturation of the whey proteins in the cheesemilk was effective in reducing the rate of exudation, possibly due to the complex formation between ß-lactoglobulin and κ-casein that prevented fusion of casein micelles.

Residual lactose and pH did not change, and proteolysis was not detected up to 16 weeks in Cream cheese stored at 5°C. It is concluded that exudation from Cream cheese does not occur due to any gross chemical changes during storage.

Manufacture of Feta cheese involved the use of recombined cow's milk and vacuum packaging of cheese after brining. A storage study of Feta cheese up to 6 months showed steady proteolysis, slow metabolism of residual lactose and a gradual decrease of pH. The water activity of the cheese depended on the salt-in-moisture concentration.

In Feta cheese the amount of exudate increased with increased P/F ratio, increased pH at draining, increased residual rennet, packaging cheese without vacuum, increased storage temperature and increased storage time. Variation of priming time, with a constant curd pH at draining, did not affect exudation. Unlike Cream cheese, an increase in protein and a decrease in fat content in Feta correlated with increase in the amount of exudate. The effects of change in pH and calcium (within a range expected in normal Feta) on exudation were minor.

Homogenisation was effective in reducing the rate of exudation in Feta cheese. However, a variation in the homogenisation pressure had no effect. The type of material adsorbed to the fat globule surface influences syneresis during manufacture as well as subsequent exudation during storage. The effect of a reduction in the size of fat globules on exudation appears to be less important.

In Feta cheese the incorporation of heat-denatured whey proteins did not affect exudation. However, there was a substantial increase in yield.

Proteolysis is the dominant factor affecting exudation. Its influence is apparently due to the disintegration of the casein network and the release of water physically held in the capillaries. Exudation is also substantially influenced by the gradient in NaCl concentration in Feta cheese following brining.

Denaturation of whey proteins in Cream cheese; and homogenisation, controlled proteolysis, decreased salt gradient, use of vacuum packaging in Feta cheese appear to be the main factors available for reducing the extent of exudation. Based on the findings of the investigation a hypothesis is proposed to explain the exudation from cheeses.

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ABBREVIATIONS

ANOVA	Analysis of variance
A_w	Water activity
BSA	Bovine serum albumin
cm	Centimetre
d	Day
DDM	Dairy division manual
DM	Dry matter
DTE	Dithioerythritol
EDTA	Ethylene diamine tetra-acetic acid
F	F ratio
FDM	Fat in dry matter
FFMR	Fresh frozen milkfat for recombining
FGS	Fat globule size
f.p.	Freezing point
g	Gram
GMS	Glycero mono stearate
h	Hour
HPLC	High performance liquid chromatography
HTST	High temperature short time
IDF	International Dairy Federation
kg	Kilogram
kPa	Kilopascal
L	Litre
LHSMP	Low heat skim milk powder
LSM	Least square mean
m	Metre
M	Molar concentration
MFGM	Milk fat globule membrane
mg	Milligram
min	Minute (time)
ml	Millilitre
mm	Millimetre
mMol	Millimole
MNFS	Moisture in non-fat substance
mo	Month
m.p.	Melting point
nm	Nanometre

ns	Not significant
NSLAB	Non starter lactic acid bacteria
NZDRI	New Zealand Dairy Research Institute
PAGE	Poly acrylamide gel electrophoresis
P/F	Protein/fat
ppm	Parts per million
psi	Pounds per square inch
rpm	Revolutions per minute
RSM	Reconstituted skim milk
RU	Rennet unit
s	Second (time)
S.D.	Standard deviation
SDS	Sodium dodecyl sulphate
SES	Simulated external solution
S/M	Salt/moisture
SMP	Skim milk powder
SNF	Solids-not-fat
TN	Total nitrogen
TS	Total solids
UF	Ultrafiltration
UHT	Ultra-high temperature
wk	Week
WPC	Whey protein concentrate
WPNI	Whey protein nitrogen index
wt	Weight
w/v	Weight/volume
v/v	Volume/volume
w/w	Weight/weight
α-	Alpha-
ß-	Beta-
κ-	Kappa-
°C	Degree Celsius (Centigrade)
μm	Micrometre
%	Per centum
>	Greater than
≥	Greater than or equal to; not less than
<	Less than
≤	Less than or equal to; not greater than