



ENZYMATIC TRANSFORMATION OF LACTOSE AND PROTEIN OF MILK WHEY

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**CODED AND UNCODED SETTINGS OF FOUR
FACTORS FOR HYDROLYSIS
OF CHEESE WHEY LACTOSE ACCORDING TO FULL
FACTORIAL DESIGN**

| Factor | Level | | |
|---|--------------|------------|------------|
| | -1 | 0 | 1 |
| Temperature (°C) | 38 | 45 | 52 |
| Lactose concentration (%) | 10 | 15 | 20 |
| Enzyme dosage (% on lactose basis) | 0,5 | 1,0 | 1,5 |
| pH | 3,6 | 4,4 | 5,2 |

EFFECT ESTIMATES AND REGRESSION COEFFICIENTS FOR CODED SETTINGS OF INDEPENDENT VARIABLES

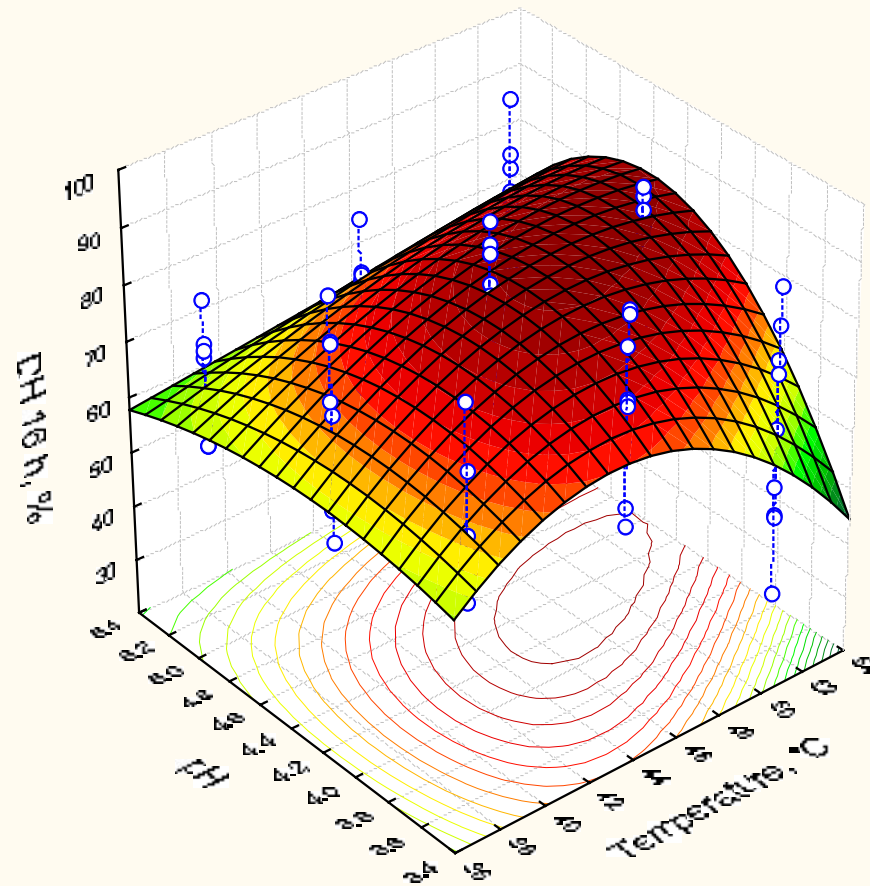
Var.:DH 16 h, %; R-sqr=,85434; Adj:,83112 (3(4-0) full factorial design, 1 block , 81 runs 4 3-level factors, 1 Blocks, 81 Runs; MS Residual=31,3989 DV: DH 16 h, %**

| Factor | Effect | Std.Err. | t(20) | p | Coeff. | Std.Err. Coeff. |
|---------------------------------|----------|----------|----------|----------|----------|-----------------|
| Mean/Interc. | 63,8998 | 1,078389 | 59,25484 | 0,000000 | 63,8998 | 1,078389 |
| (1) Temperature, °C(Q) | 6,0441 | 1,320751 | 4,57624 | 0,000020 | 3,0220 | 0,660376 |
| (2) Lactose concentration, %(L) | -7,8778 | 1,525072 | -5,16551 | 0,000002 | -3,9389 | 0,762536 |
| (3) Enzyme dosage, %(L) | 23,0278 | 1,525072 | 15,09947 | 0,000000 | 11,5139 | 0,762536 |
| (4) pH(L) | -22,1778 | 3,050144 | -7,27106 | 0,000000 | -11,0889 | 1,525072 |
| pH (Q) | 20,2504 | 2,641502 | 7,66623 | 0,000000 | 10,1252 | 1,320751 |
| 1L by 2L | 5,1500 | 1,867824 | 2,75722 | 0,007454 | 2,5750 | 0,933912 |
| 1L by 3L | 4,0000 | 1,867824 | 2,14153 | 0,035765 | 2,0000 | 0,933912 |
| 1L by 4Q | 6,6907 | 1,320751 | 5,06586 | 0,000003 | 3,3454 | 0,660376 |
| 1Q by 4L | -7,3386 | 1,617583 | -4,53678 | 0,000023 | -3,6693 | 0,808792 |
| 2L by 4L | 5,4944 | 1,867824 | 2,94163 | 0,004442 | 2,7472 | 0,933912 |
| 2Q by 4L | -2,0661 | 1,617583 | -1,27728 | 0,205784 | -1,0331 | 0,808792 |

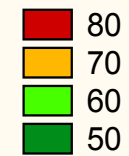
REGRESSION COEFFICIENTS AND STATISTIC SIGNIFICANCE ESTIMATES

| Var.:DH 16 h, %; R-sqr=0,853 | | | | |
|--|-----------------|-----------|---------|----------|
| Dependent variable: degree of hydrolysis 16 h, % | | | | |
| Factor | Regressn Coeff. | Std. Err. | t(20) | p |
| Intercept | 35,634 | 214,3562 | 0,16624 | 0,868469 |
| Temperature | 16,827 | 10,9284 | 1,53973 | 0,128336 |
| Temperature ² | -0,489 | 0,1594 | -3,0640 | 0,003145 |
| Lactose concentration | -31,720 | 13,4991 | -2,3498 | 0,021740 |
| Enzyme dosage | 22,1778 | 3,050144 | 7,27106 | 0,000000 |
| pH | -129,67 | 59,3616 | -2,1843 | 0,032441 |
| pH ² | 38,307 | 12,7612 | 3,00180 | 0,003769 |
| Temp * Conc | 1,232 | 0,6071 | 2,02889 | 0,046447 |
| Temp * Conc ² | -0,002 | 0,0012 | -1,3162 | 0,192588 |
| Temp ² * Conc | -7,012 | 0,0067 | -1,8355 | 0,070868 |
| Temp * pH ² | -1,194 | 0,2796 | -4,2682 | 0,000063 |
| Temp ² * pH | 0,125 | 0,0274 | 4,57296 | 0,000021 |
| Conc * pH | 0,687 | 0,2379 | 2,88727 | 0,005227 |
| Dosage * pH ² | -0,417 | 0,2699 | -1,5441 | 0,127278 |

RESPONSE SURFACE OF THE EFFECT OF PH AND TEMPERATURE ON A DEGREE OF HYDROLYSIS (%)



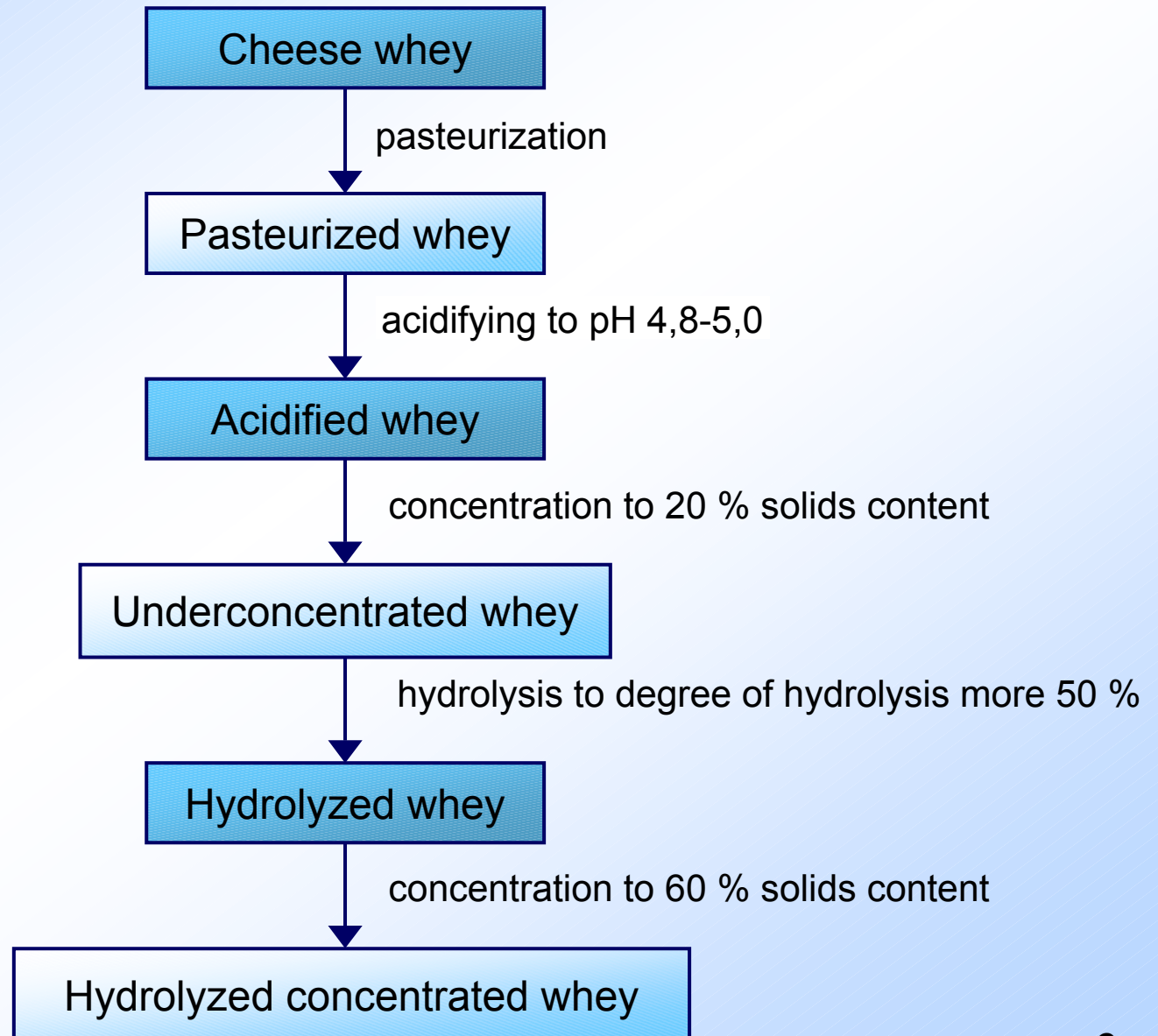
Temperature - 45°C, enzyme dosage - 1 %, time - 16 h



OPTIMAL AND CORRECTED CONDITIONS OF CHEESE WHEY LACTOSE HYDROLYSIS

| | Optimal conditions of hydrolysis | Corrected conditions of hydrolysis |
|---|---|---|
| Temperature (°C) | 48 | 50-52 |
| Lactose concentration (%) | 10 | 15 |
| Enzyme dosage (% on lactose basis) | 1,5 | 0,7-1,0 |
| pH | 4,4 | 4,6-5,0 |
| Time, h | 16 | 16 |
| Degree of hydrolysis, % | 80 | 60-65 |

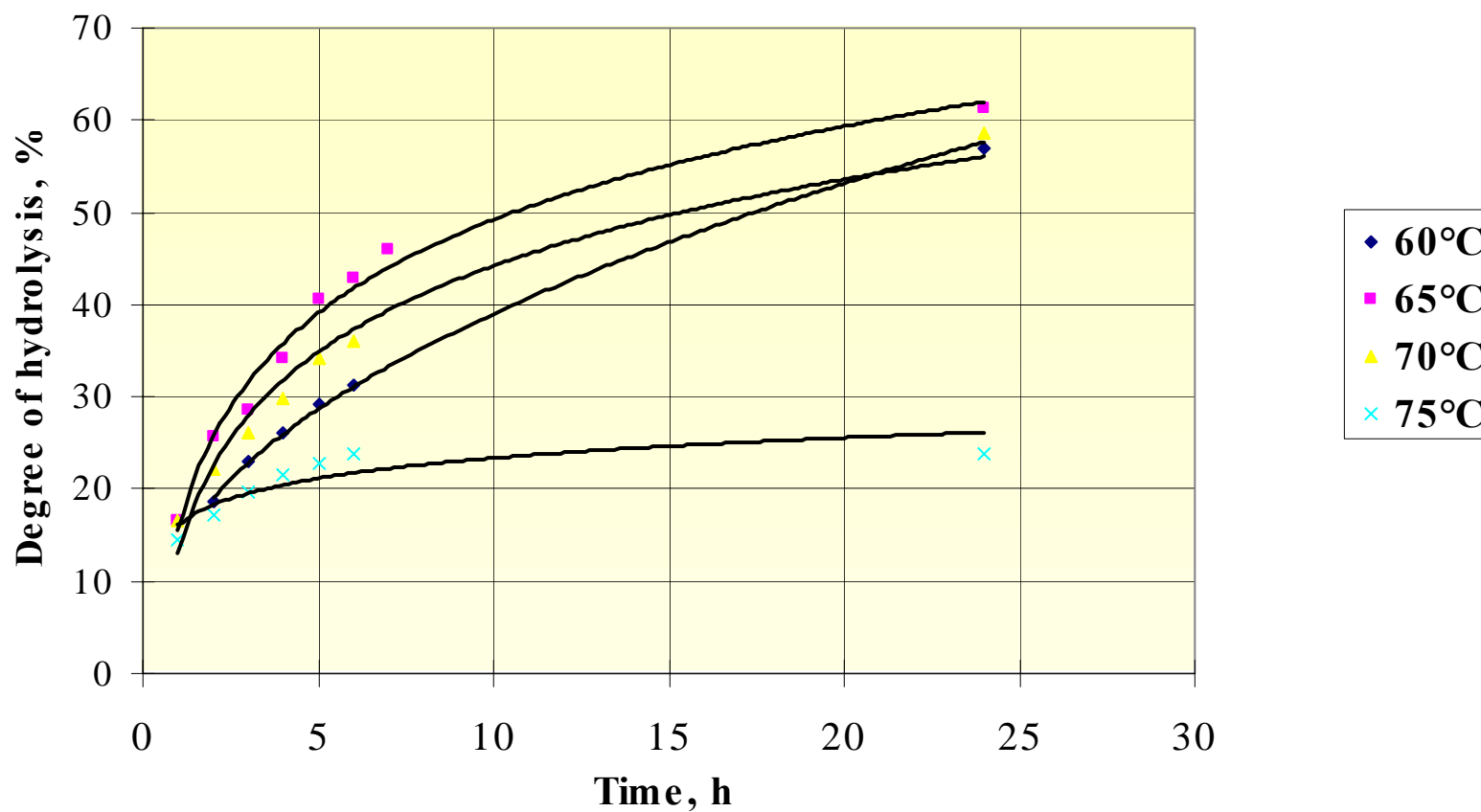
PROCESS LAYOUT FOR THE PRODUCTION OF CONCENTRATED CHEESE WHEY WITH HYDROLYZED LACTOSE (HYDROLYZED CONCENTRATED WHEY)



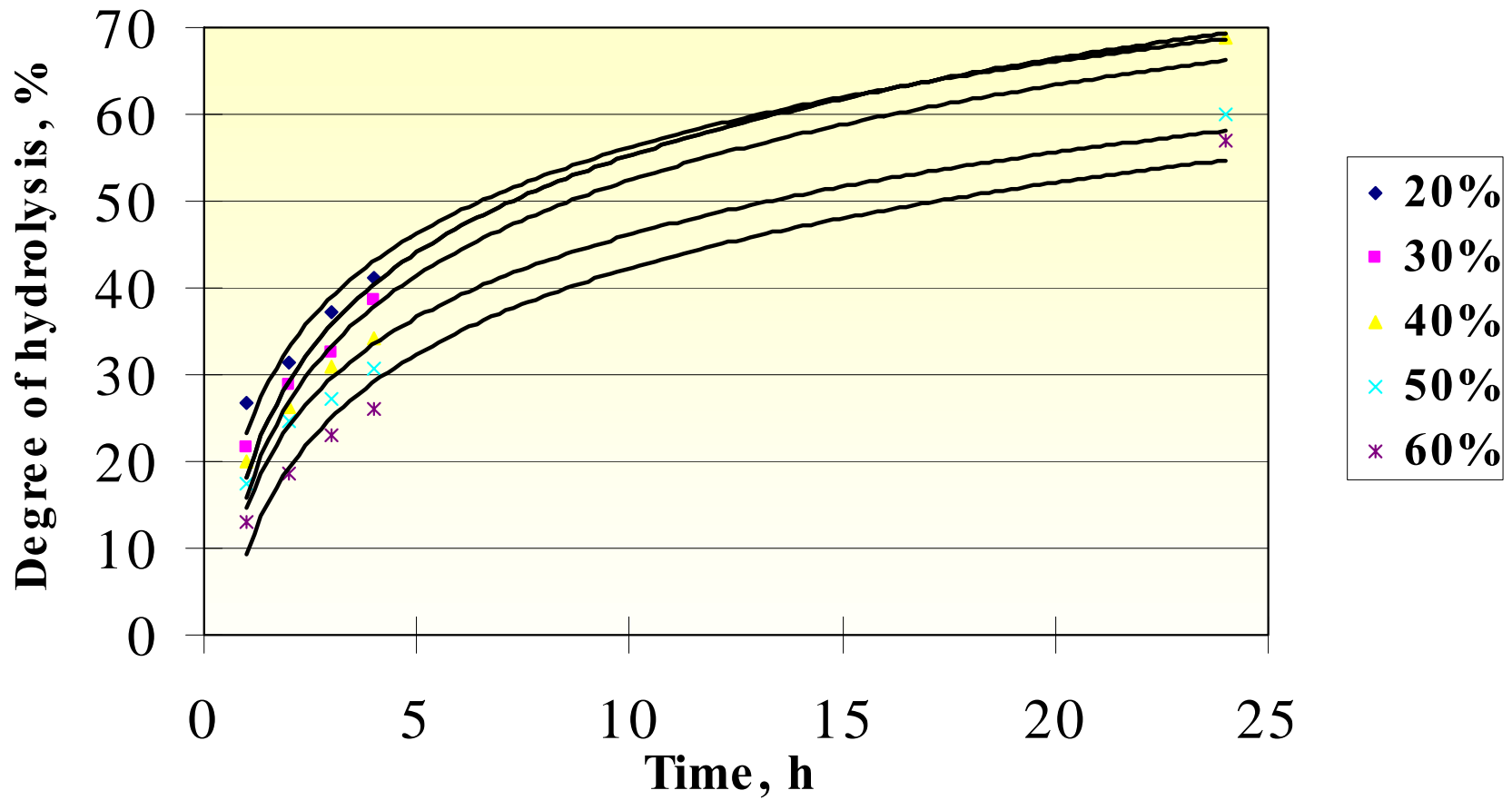
**PHYSICOCHEMICAL PROPERTIES OF HYDROLYZED
CONCENTRATED WHEY (HCW), PRODUCED FROM CHEESE
WHEY WITH DIFFERENT SALT CONTENT**

| Characteristics | HCW produced from sweet cheese | HCW produced from mixture of sweet and salt cheese | HCW produced from salt cheese |
|----------------------------------|---------------------------------------|---|--------------------------------------|
| Dry matter, % | 60,2-61,0 | 60,0-60,8 | 60,5-61,3 |
| Degree of hydrolysis, % | 58,0-67,0 | 56,0-65,0 | 59,0-67,0 |
| Reducing sugars , % | 46,8-49,2 | 43,4-45,7 | 40,3-41,5 |
| including: glucose, % | 13,6-16,5 | 12,2-14,8 | 11,9-13,9 |
| galactose (calc.), % | 13,6-16,5 | 12,2-14,8 | 11,9-13,9 |
| lactose (calc.), % | 16,2-19,6 | 16,1-19,0 | 13,7-16,5 |
| NaCl, % | 2,5-3,3 | 6,9-7,6 | 10,5-11,2 |
| Titratable acidity, °T | 240-250 | 230-240 | 230-240 |

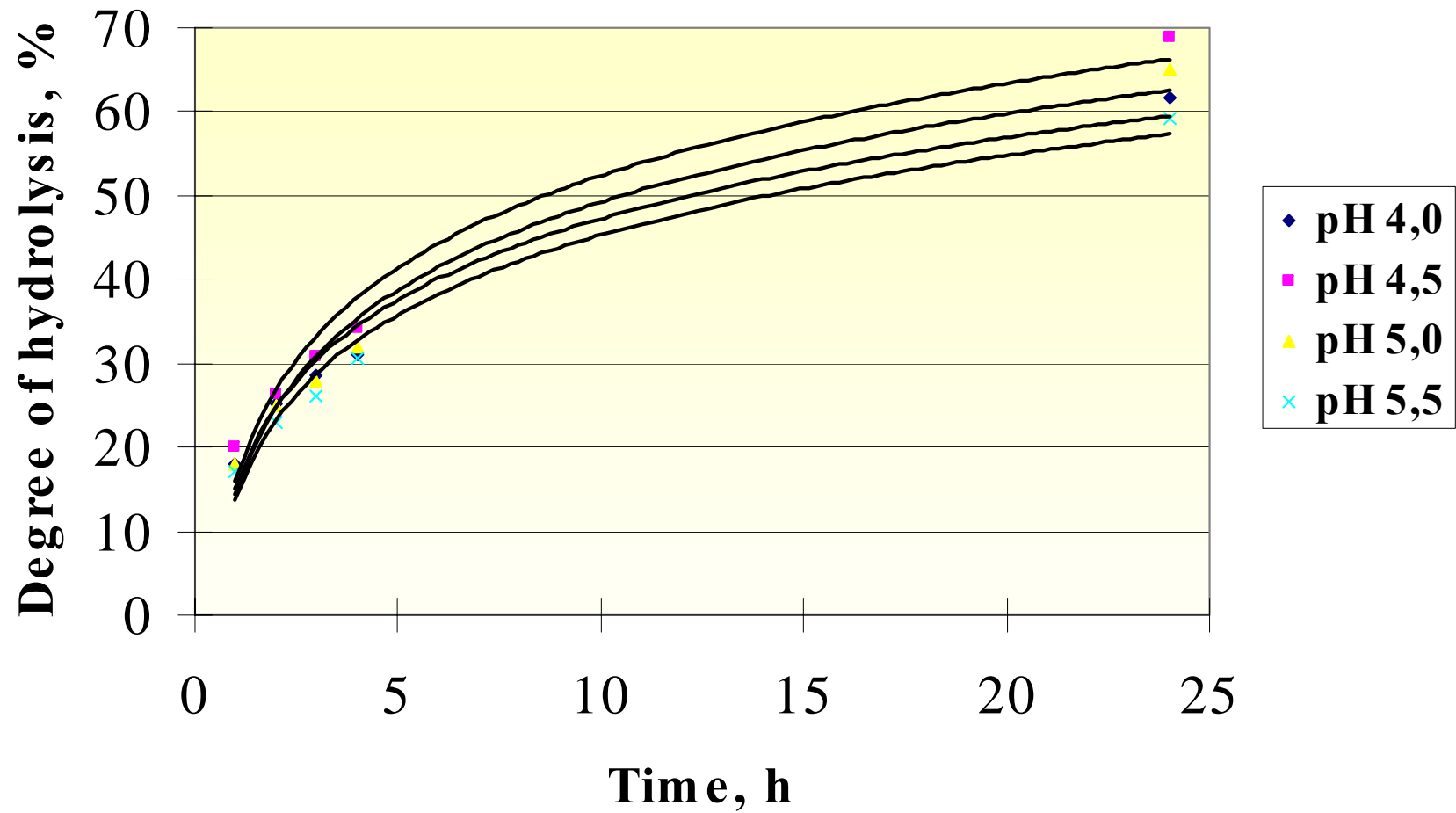
Lactose hydrolysis in 60 % solution at different temperatures



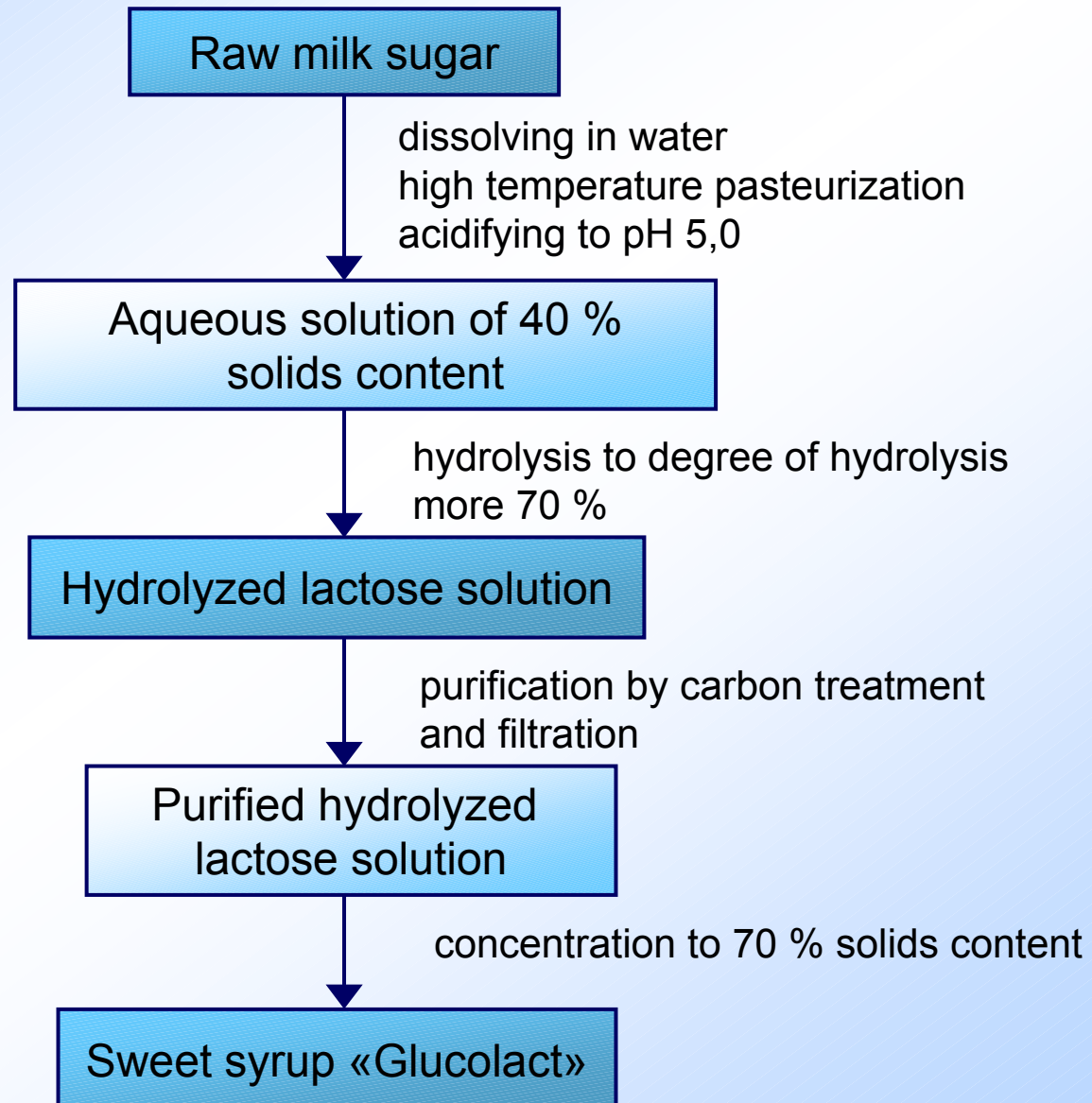
Lactose hydrolysis at 60°C in solutions of different solids content



Lactose hydrolysis at 60°C and solids content of 40 % at different pH



PROCESS LAYOUT FOR THE PRODUCTION OF SWEET SYROP «GLUCOLACT» FROM RAW MILK SUGAR



PHYSICO-CHEMICAL PROPERTIES OF SWEET SYRUP «GLUCOLACT» PRODUCED FROM RAW MILK SUGAR

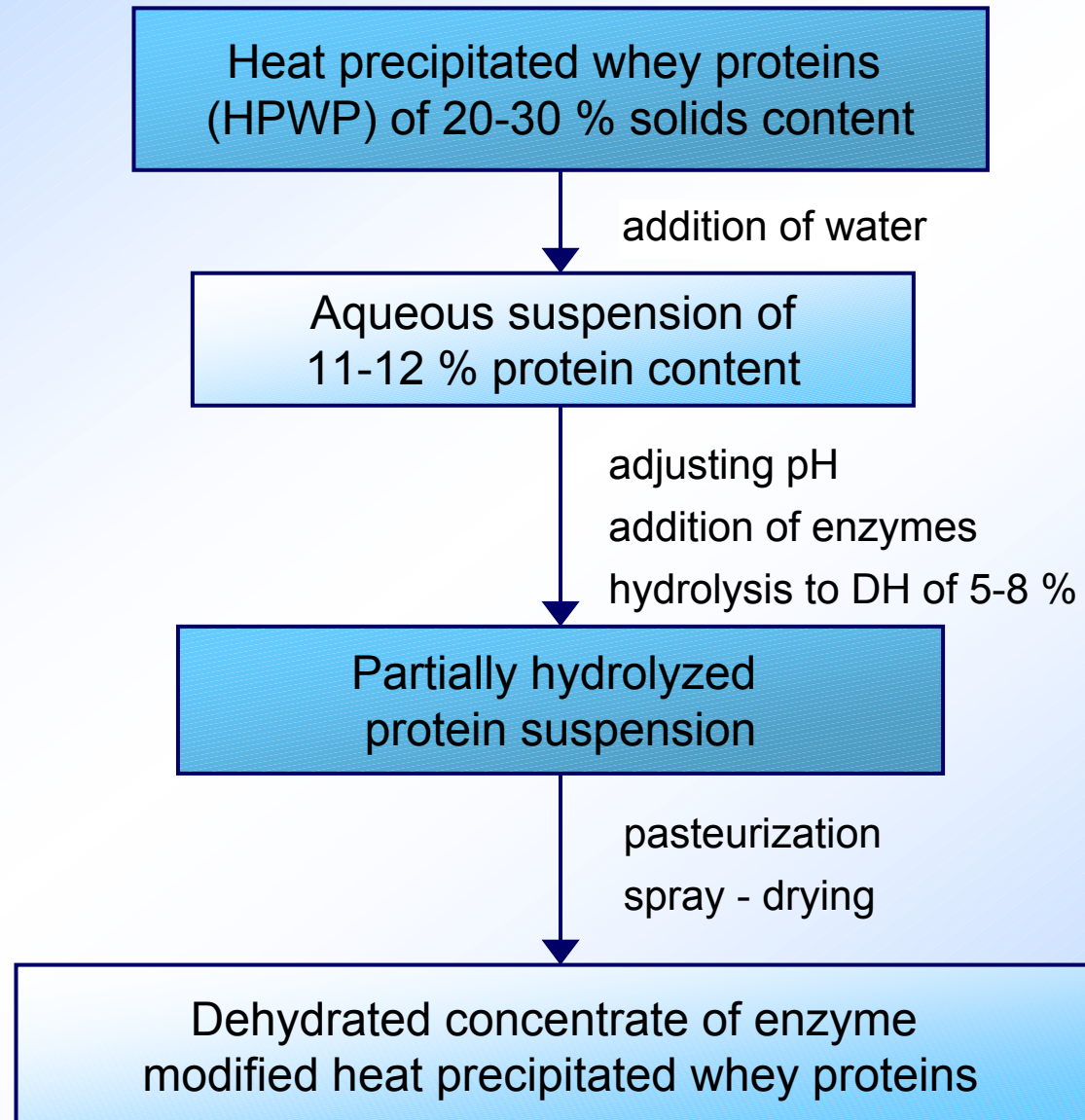
| Characteristics | |
|--------------------------------|------------------|
| Dry matter, % | 70,0-72,0 |
| Degree of hydrolysis, % | 68,0-70,0 |
| Reducing sugars, % | 66,0±0,2 |
| including: | |
| glucose, % | 23,0-24,0 |
| galactose (calc.), % | 23,0-24,0 |
| lactose (calc.), % | 20,0-21,0 |
| Titratable acidity, °T | 40-50 |

COMPOSITION OF HPWP PRODUCED BY DIFFERENT SEPARATION METHODS

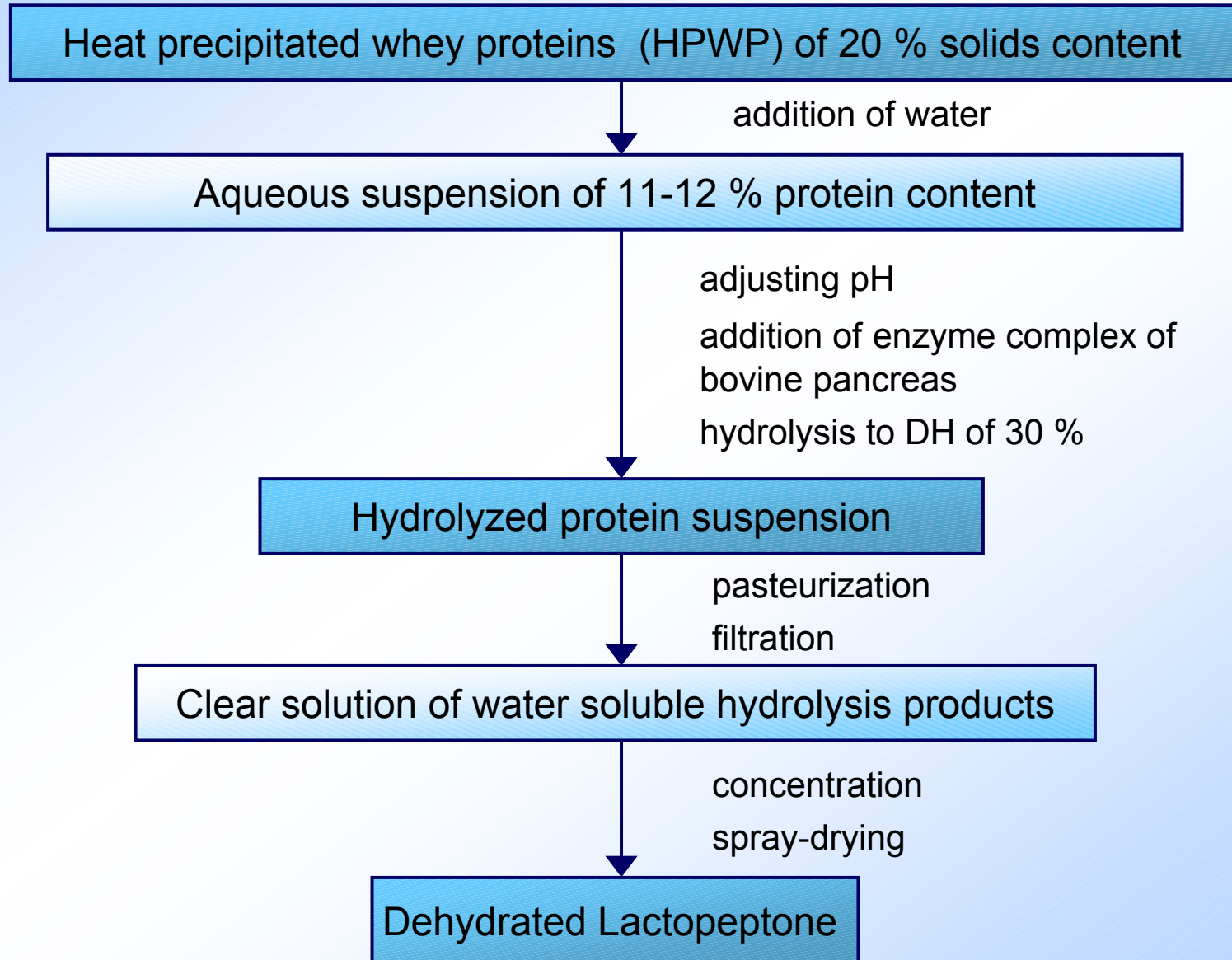
| Characteristics | Method of separation of mixture containing whey and whey proteins precipitate | | |
|--------------------------------|---|--------------------|---|
| | draining | draining +pressing | draining + freezing + unfreezing + pressing |
| Solids, % | 20±1 | 30±1 | 35±1 |
| Moisture, % | 80±1 | 70±1 | 65±1 |
| Solids: | | | |
| proteins, % | 68,3±3,2 | 81,0±3,3 | 83,3±3,4 |
| fat, % | 6,8±3,2 | 6,7±3,4 | 7,0±3,6 |
| lactose, % | 20,5±1,0 | 10,0±0,7 | 8,0±0,5 |
| salts, % | 4,5±0,5 | 2,3±0,3 | 1,7±0,3 |
| Titrateable acidity, °T | 35,0-40,0 | 60,0-65,0 | 65,0-68.0 |

Fat content in separated original whey is 0,02-0,05 %

PROCESS LAYOUT FOR THE PRODUCTION OF ENZYME MODIFIED HEAT PRECIPITATED WHEY PROTEINS



PROCESS LAYOUT FOR THE PRODUCTION OF LACTOPEPTONE FOR MICROBIOLOGICAL CULTURE MEDIA



AVARAGE ANALYSIS OF LACTOPEPTONE

| Characteristics | |
|------------------------------------|-----------------|
| pH of 2% sol. after boiling | 6,6-7,0 |
| Water, % | 7,0±0,5 |
| Total nitrogen, % | 11,2±0,2 |
| including: | |
| proteose nitrogen, % | 2,8±0,1 |
| amino-acid nitrogen, % | 5,1±0,2 |
| Nitrogenous substances | 71,2±2,6 |
| including: | |
| amino-acids | 31,2±1,8 |
| peptides | 40,0±2,5 |
| Lactose, % | 13,5±1,5 |
| Ash, % | 5,6±0,2 |

AVERAGE ANALYSIS OF HYDROLYSATE OF MILK WHEY PROTEINS FOR TISSUE CULTURE

| Characteristics | |
|-----------------------------|----------|
| pH of 2% sol. after boiling | 6,6-7,0 |
| Water, % | 6,0±0,5 |
| Total nitrogen, % | 11,9±0,2 |
| including: | |
| protease nitrogen, % | 2,8±0,1 |
| amino-acid nitrogen, % | 6,3±0,2 |
| Nitrogenous substances | 79,7±2,6 |
| including: | |
| amino-acids | 48,6±2,3 |
| peptides | 31,1±1,8 |
| Lactose, % | 7,5±1,5 |
| Ash, % | 5,8±0,2 |

AVERAGE AMINO ACIDS COMPOSITION OF MILK WHEY PROTEIN HYDROLYSATE (%)

| Name of acid | FREE AMINO ACIDS | AMINO ACIDS AFTER ACID HYDROLYSIS |
|--------------------------|------------------|-----------------------------------|
| Asparagine+Aspartic acid | 1,9 | 7,8 |
| Threonine | 1,8 | 4,6 |
| Serine | 4,6 | 4,5 |
| Glutamine +Glutamic acid | 4,2 | 8,5 |
| Proline | 0,3 | 3,8 |
| Glycine | 0,8 | 2,0 |
| Alanine | 3,3 | 4,9 |
| Cysteine | 2,6 | 2,0 |
| Valine | 3,4 | 4,5 |
| Methionine | 1,6 | - |
| Isoleucine | 2,3 | 4,4 |
| Leucine | 7,2 | 7,8 |
| Tyrosine | 0,8 | 0,8 |
| Phenylalanine | 2,9 | 2,9 |
| Lysine | 4,1 | 4,1 |
| Histidine | 1,6 | 2,1 |
| Arginine | 2,5 | 2,6 |
| Tryptophane | 2,7 | - |
| Sum total: | 48,6 | |