



# 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**

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

## EFFECT ESTIMATES AND REGRESSION COEFFICIENTS FOR CODED SETTINGS OF INDEPENDENT VARIABLES

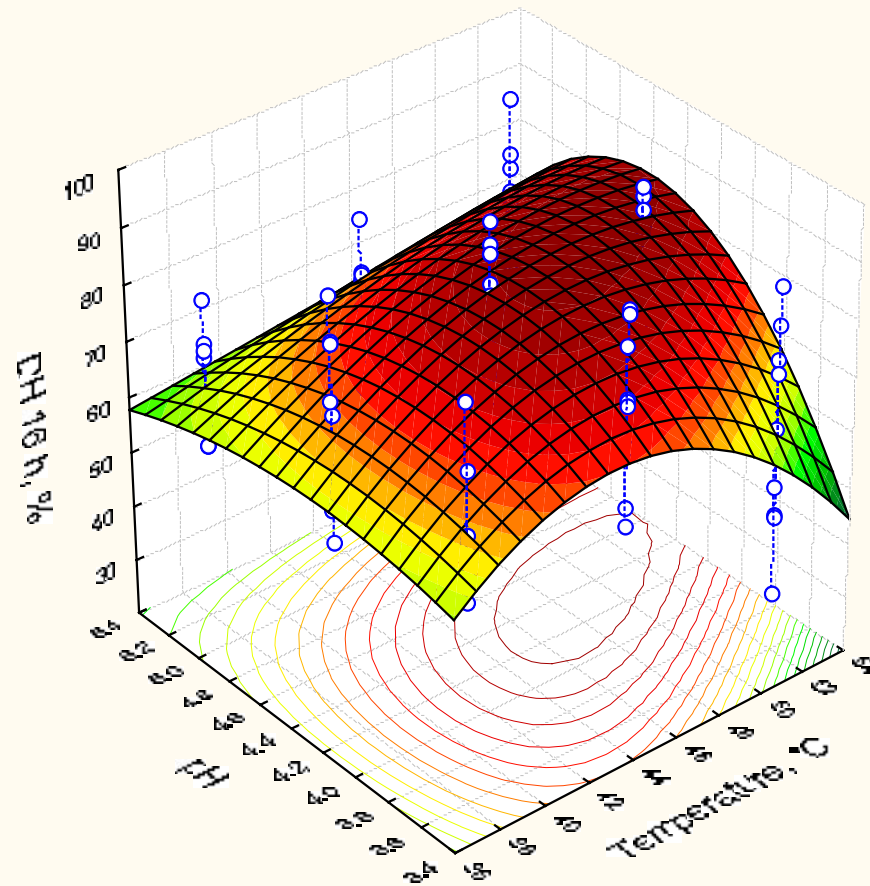
**Var.:DH 16 h, %; R-sqr=,85434; Adj:,83112 (3\*\*(4-0) full factorial design, 1 block , 81 runs 4 3-level factors, 1 Blocks, 81 Runs; MS Residual=31,3989 DV: DH 16 h, %**

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

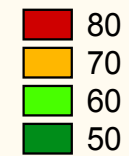
## REGRESSION COEFFICIENTS AND STATISTIC SIGNIFICANCE ESTIMATES

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 <sup>2</sup>	-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 <sup>2</sup>	38,307	12,7612	3,00180	0,003769
Temp * Conc	1,232	0,6071	2,02889	0,046447
Temp * Conc <sup>2</sup>	-0,002	0,0012	-1,3162	0,192588
Temp <sup>2</sup> * Conc	-7,012	0,0067	-1,8355	0,070868
Temp * pH <sup>2</sup>	-1,194	0,2796	-4,2682	0,000063
Temp <sup>2</sup> * pH	0,125	0,0274	4,57296	0,000021
Conc * pH	0,687	0,2379	2,88727	0,005227
Dosage * pH <sup>2</sup>	-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

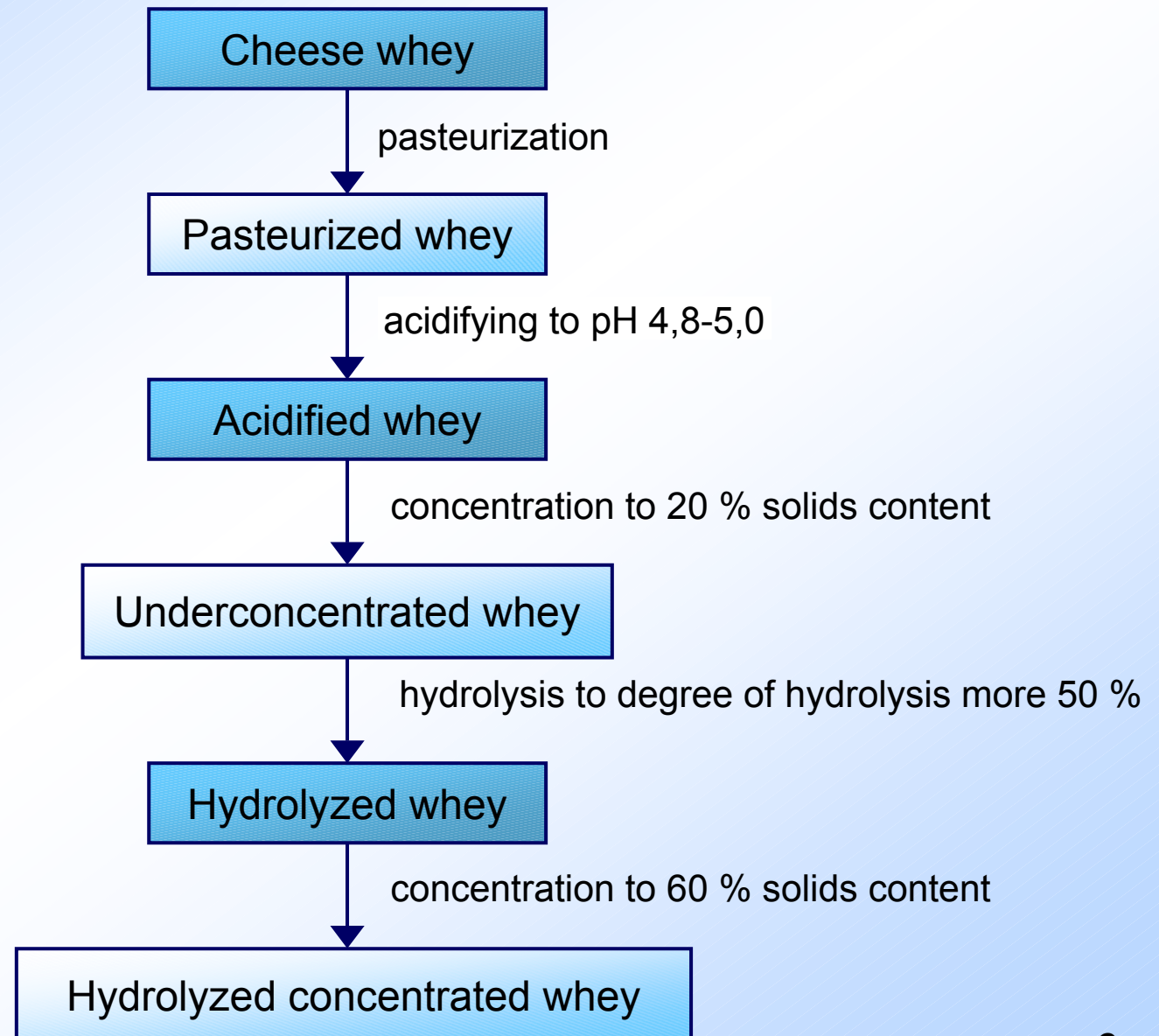




## OPTIMAL AND CORRECTED CONDITIONS OF CHEESE WHEY LACTOSE HYDROLYSIS

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

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

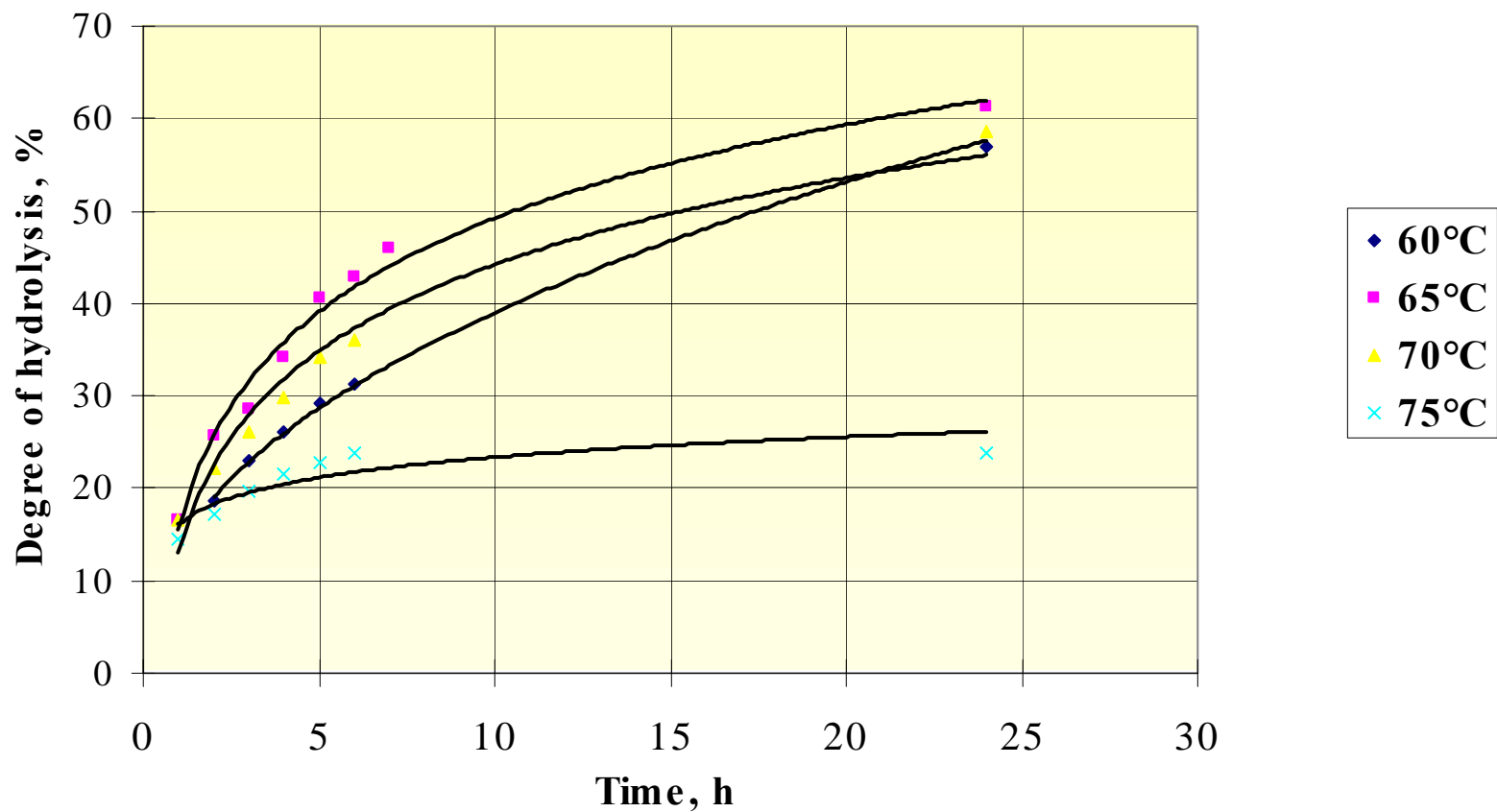


**PHYSICOCHEMICAL PROPERTIES OF HYDROLYZED  
CONCENTRATED WHEY (HCW), PRODUCED FROM CHEESE  
WHEY WITH DIFFERENT SALT CONTENT**

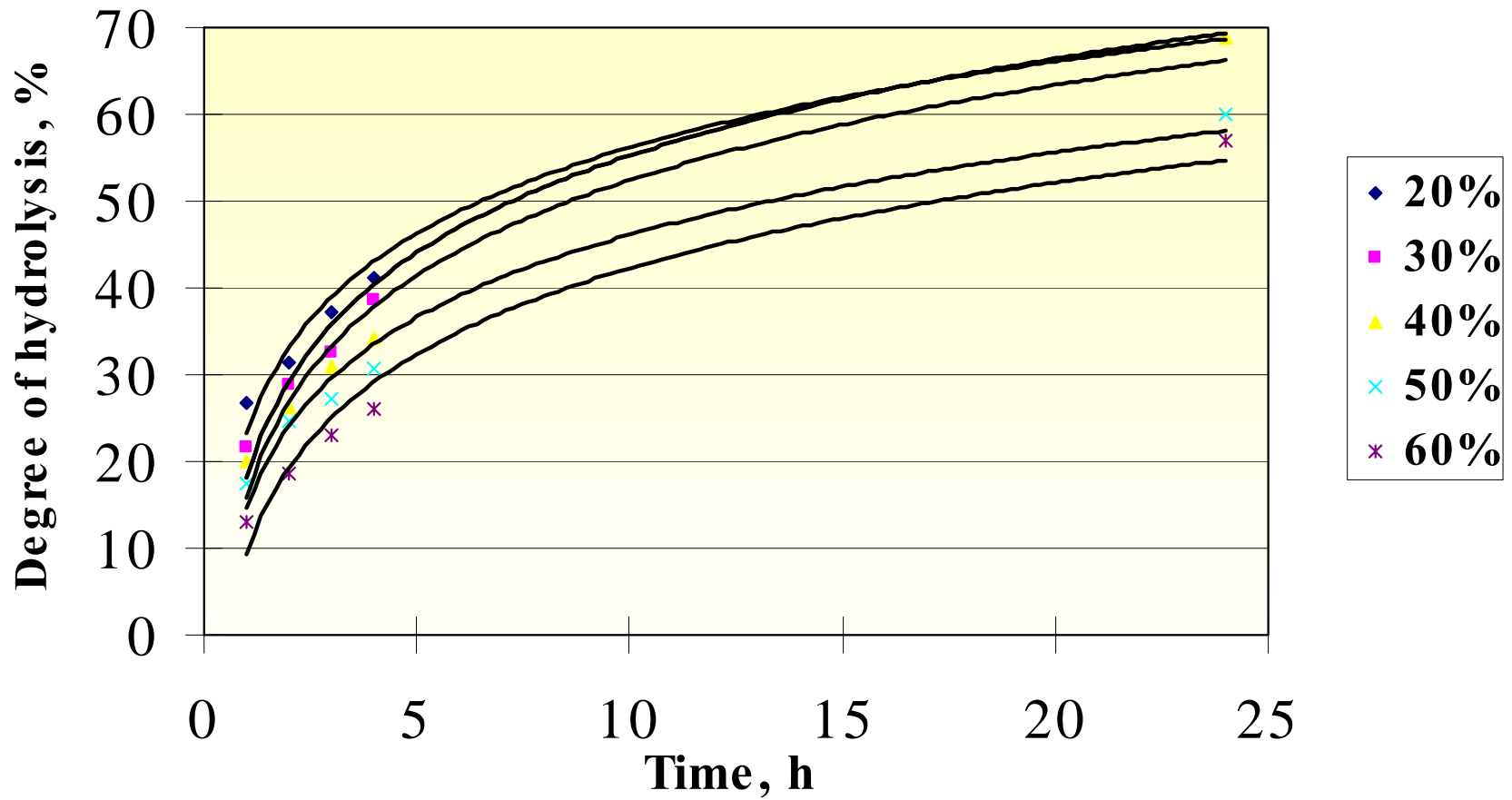
<b>Characteristics</b>	<b>HCW produced from sweet cheese</b>	<b>HCW produced from mixture of sweet and salt cheese</b>	<b>HCW produced from salt cheese</b>
<b>Dry matter, %</b>	60,2-61,0	60,0-60,8	60,5-61,3
<b>Degree of hydrolysis, %</b>	58,0-67,0	56,0-65,0	59,0-67,0
<b>Reducing sugars , %</b>	46,8-49,2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



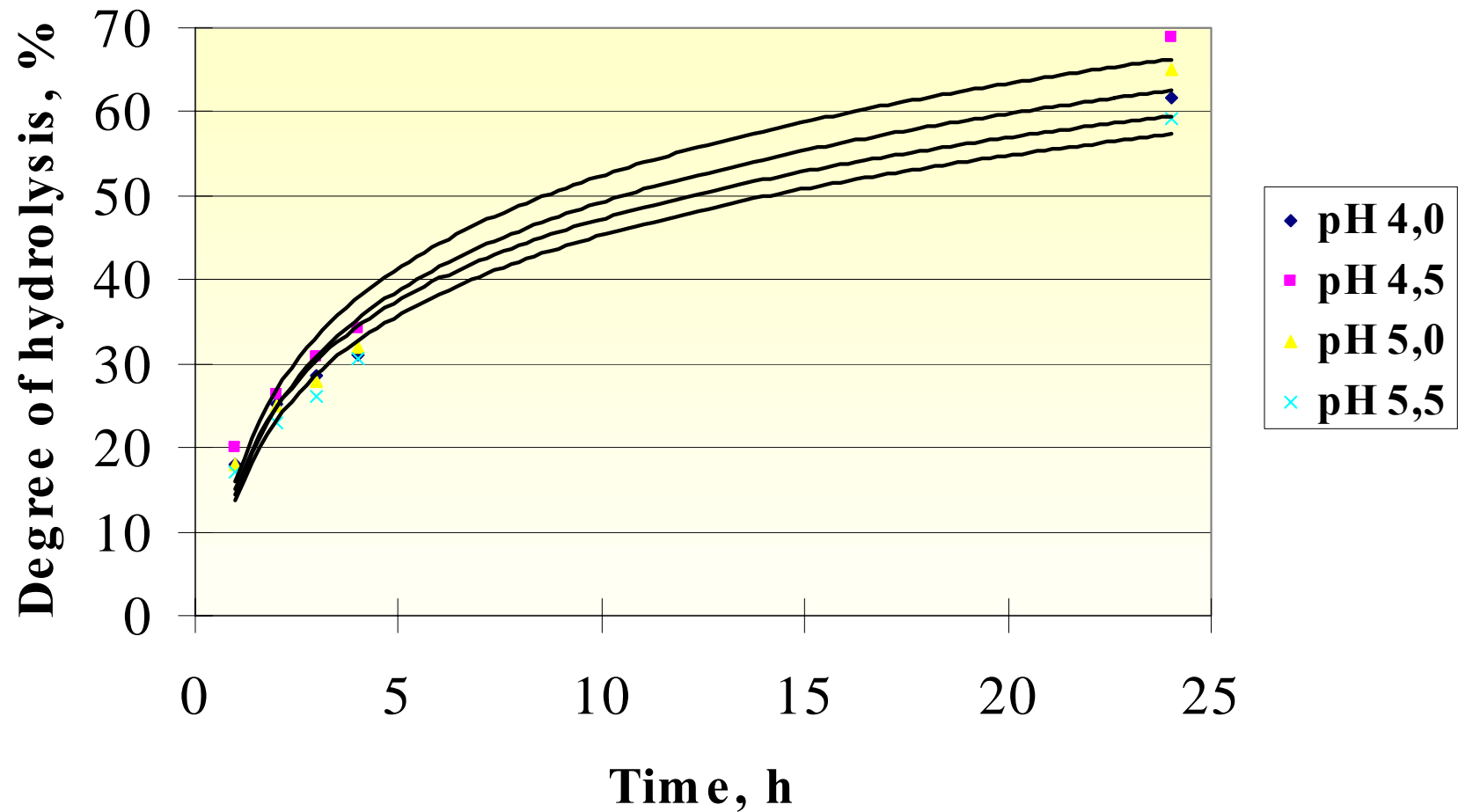
## Lactose hydrolysis in 60 % solution at different temperatures



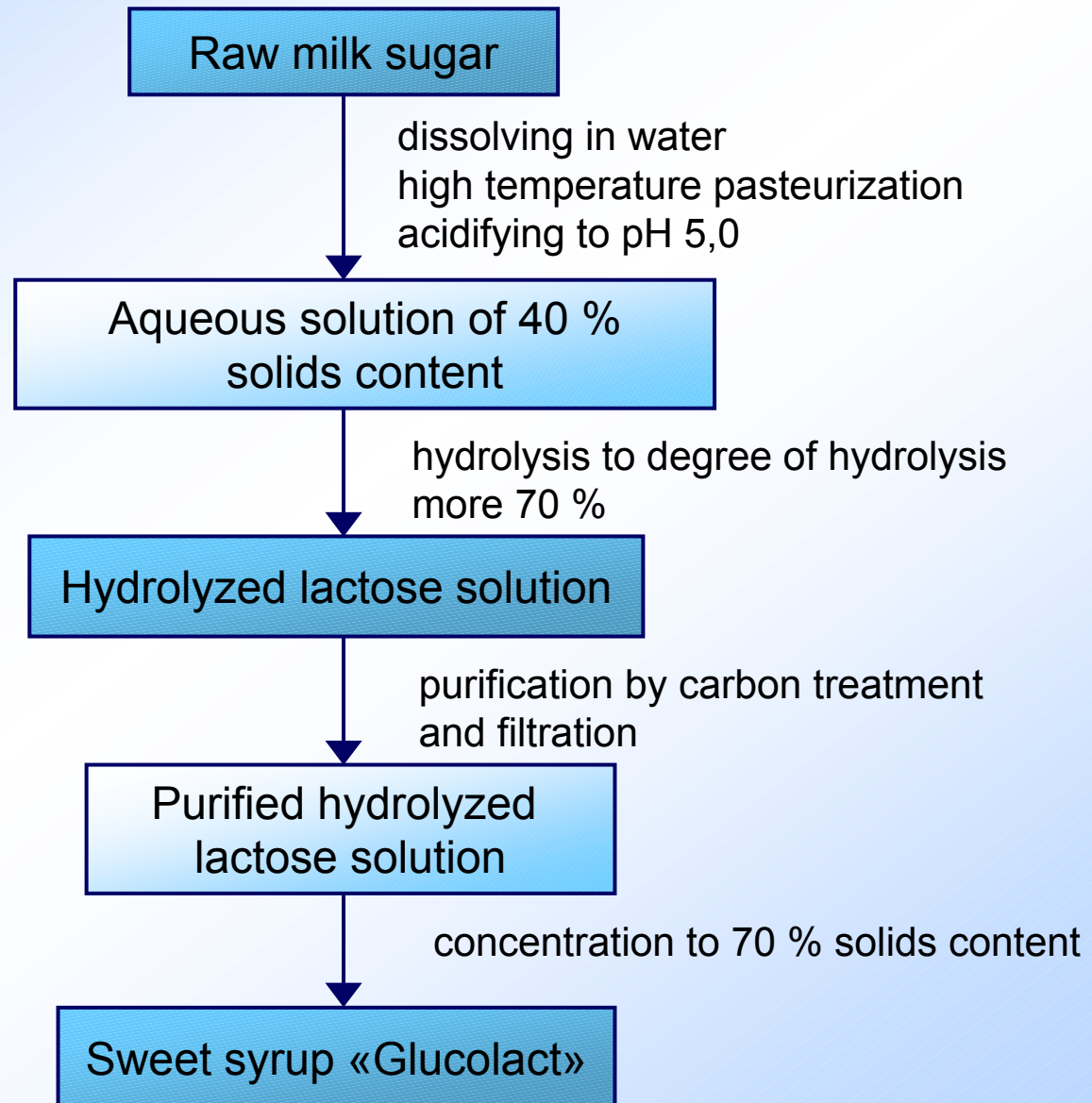
Lactose hydrolysis at 60°C in solutions of different solids content



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

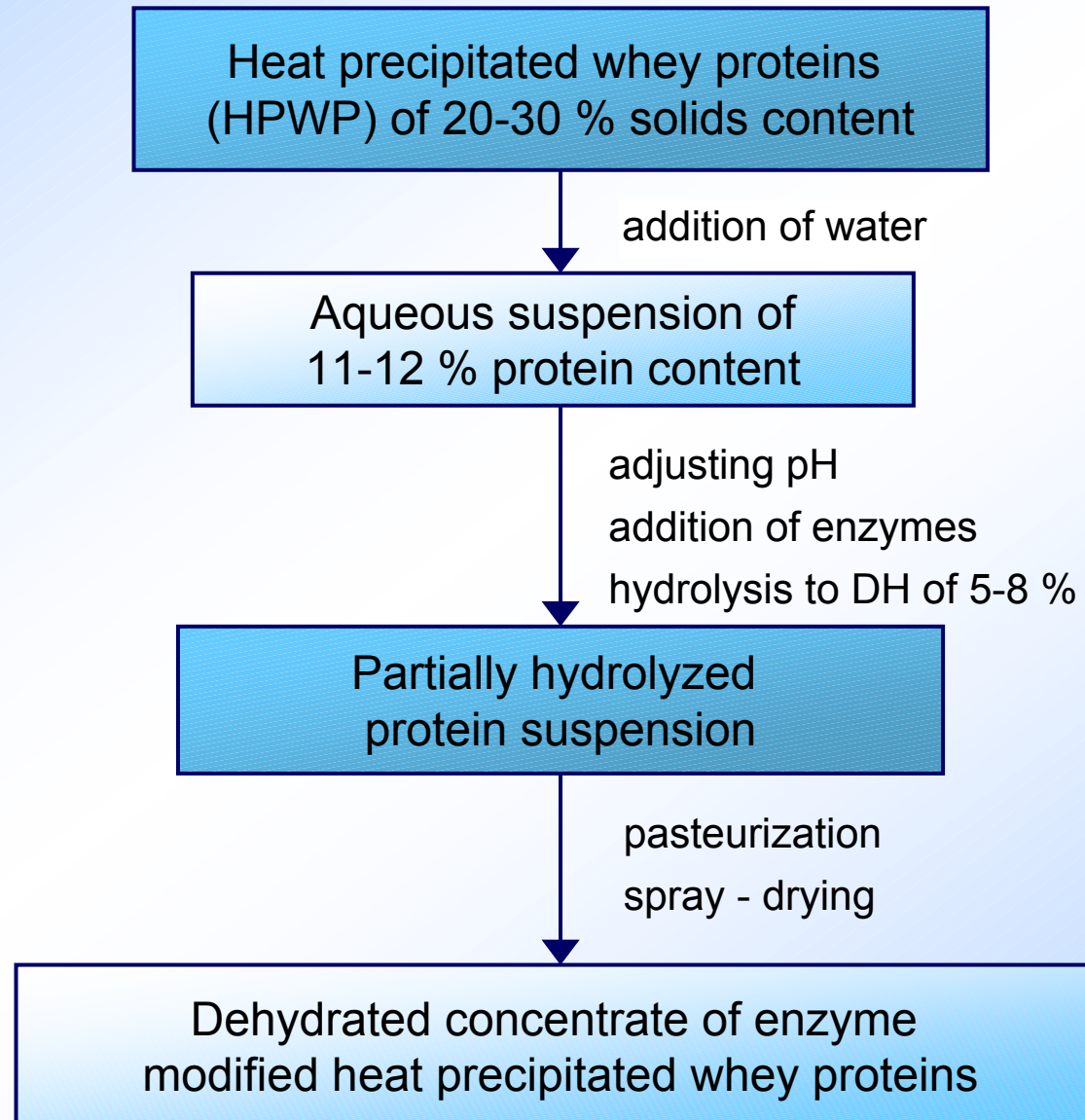


## COMPOSITION OF HPWP PRODUCED BY DIFFERENT SEPARATION METHODS

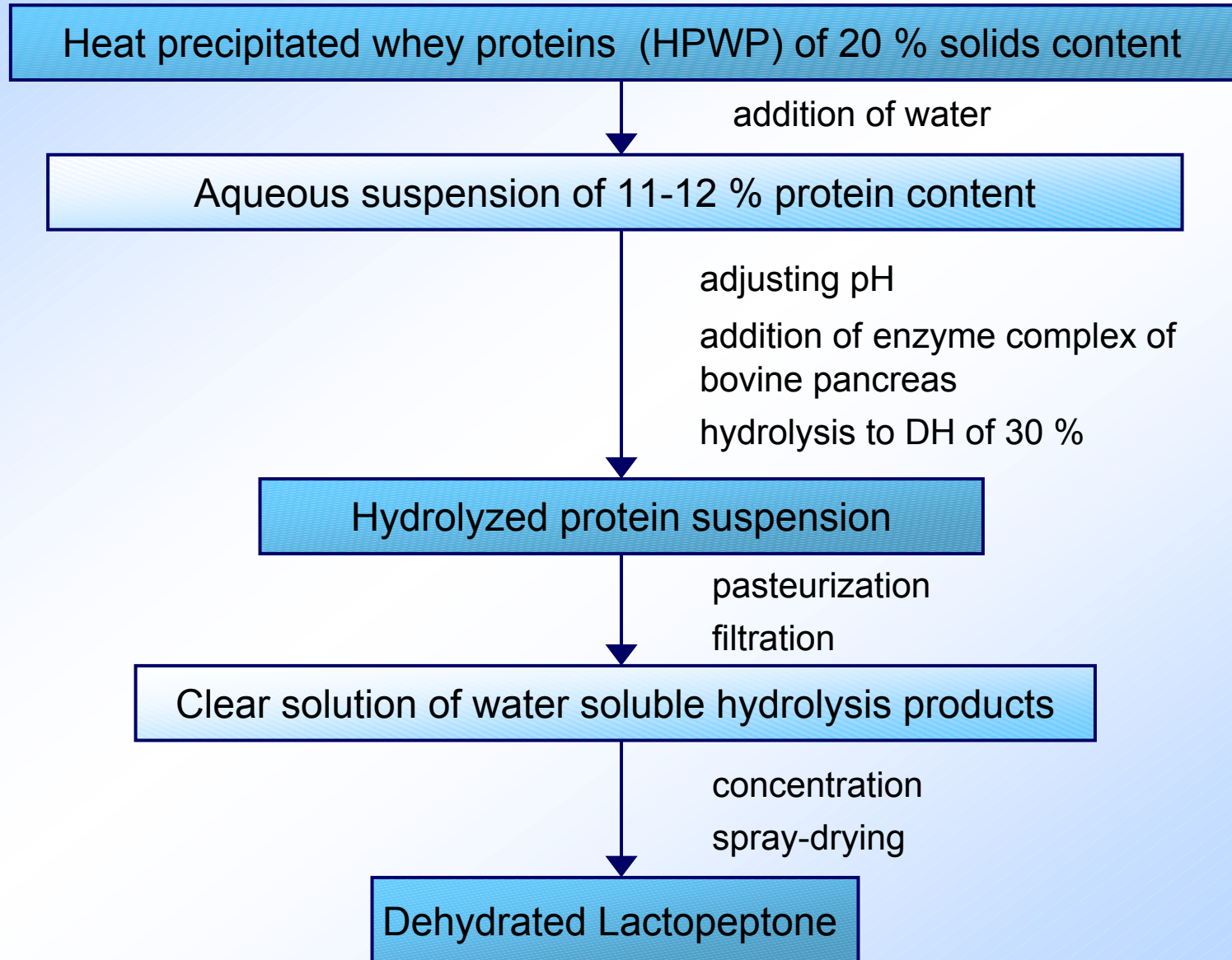
Characteristics	Method of separation of mixture containing whey and whey proteins precipitate		
	draining	draining +pressing	draining + freezing + unfreezing + pressing
<b>Solids, %</b>	20±1	30±1	35±1
<b>Moisture, %</b>	80±1	70±1	65±1
<b>Solids: proteins, %</b>	68,3±3,2	81,0±3,3	83,3±3,4
<b>fat, %</b>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

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



## 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



AVARAGE 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	-
<b>Sum total:</b>	<b>48,6</b>	