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Note

Program for processing amino acid data with a programmable pocket calculator

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The quantitative evaluation of a chromatogram obtained from an automatic amino acid analyzer is a time-consuming repetitive operation comprising integration of the area of each peak, after comparison with an appropriate standard. These operations can be accomplished by desk-top calculators¹ and electronic integrators^{2,3}. Several authors have described the use of these devices in this field and how to reduce analysis costs⁴, how to simplify the software even in the case of analyses of complex mixtures such as those of physiological fluids⁵, how to minimize the effects of noisy outputs and variable retention times⁶, how to detect the critical points of the chromatogram and how to prevent fluctuations in the base line⁷. However, the price of these devices (which represents 15–25% of the total cost of the apparatus, even for the simplest models) and the need for some knowledge of computer language put them out of reach of most laboratories.

Such repetitive routine calculations can be performed with the new programmable pocket calculators, whose prices are much lower than those of the instruments mentioned. Of course, in this case the calculator cannot be interfaced with the amino acid analyzer. Thus some parameters of the chromatogram peaks, such as height and width, must be measured manually, but once this is done the time required to process data is drastically shortened and the possibility of error is greatly diminished compared to full manual evaluation.

Buchanan⁸ reported a program for processing amino acid data with a Hewlett-Packard HP25 calculator; however, this machine has a limited number of program steps and memories, and it can process the information for only one amino acid at a time. For each peak, 1.5–2.0 min are required to evaluate the amount in nmoles, *i.e.*, the procedure must be repeated eighteen times for protein hydrolysates, making the full elaboration of data tedious and time-consuming.

The program described in this paper is written for a Texas Instruments TI59 calculator which offers a larger number of steps and memories. It enables calculation of the whole amino acid composition just by entering in separate steps the data calculated manually (total heights, baselines and widths), which are then processed automatically. The program is divided in two sections: one for calculating correction factors from a calibration run with a standard mixture (this section requires 83 steps and 58 memory registers); and another to evaluate the amino acid composition of the sample (this section requires 150 steps and 59 memory registers).

In the procedure proposed, the amino acid content is expressed as a percentage of the total recovered amino acids and as mg per g N (N = nitrogen). However, the program can easily be modified according to specific needs and the results can be expressed as desired (*e.g.*, residues per mole of protein, g per 100 g of protein, mg per g N, residues percent, g per 16 g N). Partial results can be displayed in any step of the program in order to record them on data sheets. The program described is designed for the evaluation of the amino acid composition of fully hydrolyzed samples (*i.e.*, eighteen amino acids), but can be modified to process more amino acids, as is required in the case of physiological fluid analysis.

The calculator needs only a few seconds to process all the data; of course, more time is required to manually enter the parameters of each peak. However, the whole procedure takes less than 6 min.

In our program the amount of each amino acid is expressed either as a percentage of the total recovered amino acids or as mg amino acid per g N, in which case the nitrogen content is determined by direct analysis of the sample. This method of expressing data is particularly useful in the analysis of food proteins. Moreover, by relating the determined data to the nitrogen content separately assayed, instead of to the total recovered amino acids, it is possible to correct the results for losses during the preparation and hydrolysis of the sample.

Table I shows the sequence in which the data for eighteen amino acids are processed. It also lists the memory addresses for total heights, net heights, baselines, widths, mg $\times 10^2$ of each amino acid, expansion scale and optical pathway, nitrogen

TABLE I

MEMORY ADDRESSES OF AMINO ACID DATA

Expansion scale factor and optical pathway^{*}: 19. g N/ml^{*} (only if 1 ml is the injected volume): 59. Total mg \times 10²: 39. Counting memories: 00, 20 and 40.

Amino acid	Total height*, Net height	Baseline*, Width*	Correction factor, C	Amount $(mg \times 10^2)$
His	01	21	41	01
Lys	02	22	42	02
Arg	03	23	43	03
Asp	04	24	44	04
Thr	05	25	45	05
Ser	06	26	46	06
Glu	07	27	47	07
Рго	08	28	48	03
Gly	09	29	49	09
Ala	10	30	50	10
Cys	11	31	51	11
Val	12	32	52	12
Met	13	33	53	13
Ile	14	34	54	14
Leu	15	35	55	15
Туг	16	36	56	16
Phe	17	37	57	17
Trp	18	38	58	18

 $C = (\text{Height}_{\text{standard s.s.}} \times W_{\text{standard s.s.}})/(\text{Nanomoles}_{\text{standard s.s.}} \times MW) \times 10,000.$

* These data must be entered by the operator.

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content of the sample and percentages of total recovered amino acids. Notice that when one amino acid is absent, the values 0 for total height, baseline and width and 1 for correction factor must be entered.

A schematic diagram of the program is shown in Fig. 1. Further details are given in Table II.

Program steps	Data Entry	Total heights and base lines
000-039	Calculation of net heights and net half heights	Net half heights displayed, net heights stored
	Data Entry	Widths, correction factors, selected scale and optical pathway, g N/ml
040-079	Calculation of the amount of each a.a.	Result stored
080-099	Calculation of the amount of recovered amino acids	Result stored
100-140	Calculation of amino acid % and mg amino acid/gN	Final results di- Splayed

Fig. 1. Block diagram of the program.

With the suggested procedure the calculator first computes and displays net half-heights, which indicate where to evaluate the widths of the peaks and, after these data have been measured and entered, it calculates and displays the percent of each amino acid to two decimal places and the values of mg per g N approximated to an integer. However, other partial results can be displayed if the instruction "2nd Pause", which interrupts the program for 0.5 sec, is inserted after the sequence of instructions which define them.

Correction factors for each amino acid are calculated by modifying the main program after step 039, as shown in Table III. In this case the molecular weights of the amino acids must be entered in memories 41–58. Once calculated, correction factors are automatically stored in the same memories.

The performance of the main program is checked by two different types of tests. A preliminary run can be done: if, for all total heights, the digit 2 is entered and the digit 1 for baselines, widths, correction factors, expansion scale and g N, the program should display, in turn, 5.56% and 1. Alternatively, in routine operation, the number 18 displayed at the end of each cycle indicates the correct completion of a program section. After each section, the key-stroke run/stop must be pressed in order to move the program forward.

Once correction factors are calculated and stored, eighteen peaks in a chromatogram are processed in less than 6 min, including entering the data, but excluding the manual evaluation of baselines, total heights and widths which depend on the skill of the operator.

The program steps can be recorded on magnetic cards for quick reuse. In

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TABLE II

PROGRAM FOR THE CALCULATION OF AMINO ACID COMPOSITION

Program steps	Key	Comments
000 001 002	o STO œ	Values for counting memories are set.
003 004 005 006	2 0 STO 20	
007 008 009 010 011	A A 1 8 xst	ded. 18 is put in t re- gister. Counting program.
012 013 014 015	1 SUH OO SUM	
016 017 018 019	20 RCL 2nd IND 00 -	Total heights recalled; base lines subtracted.
021 022 023 024 025 026	STO 2nd IND 00 = STO 2nd IND 00 2	Net heights are stored and divided by 2; base lines surmed.
027 028 028 030	RCL 2nd IND 20 =	ļ
031 032 033 034 035 035 036 037 038	2nd Pause 2nd Pause RCL 00 INV 2nd x=t A R/S	Net half heights diplayed The digit in memory OO is compared with t. If the value is $\angle 18$ the cycle is repeated, if = 18, is stopped.
039 040 041 042 043 043	o STO c 2 o STO	Values for counting memo- ries are reset.
045 046 047 048 049 050	20 4 0 STO 40 2nd LB1	The second loop is
051 052 053 054 055 055	B 1 SUM 00 SUM 20	Counting program.
057 058	SUM 40	↓

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TABLE II (continued)

053RCL 2nd IND 00Net heights recal- led, multiplied by widths, divided by correction factors, multiplied by expan- sion scale factor.064:.065RCL 2nd IND 066.06640067*068RCL 06706919070=071STO 2nd IND 073073RCL 07407400075INW 0750762nd x=t 077077B 0078R/S 0007900790079007900790080STO 0008100 00082STO 000832nd L21 000842nd L21 00085INV 0008400 00083R/S 0008400 00085INV 000862nd x=t 00087C 00088R/S 0009900910101STO 001022nd Lb1 00103C 0011139 1121111 114 111112* 1111132 1111140 1151151 102116= 1171172nd Fause 2 1191182 2 1191192nd Fause 2 119 <th>Program steps</th> <th>Key</th> <th>Comments</th>	Program steps	Key	Comments
G60DefDefied, miltiplied by widths, divided by correction factors, multiplied by expansion scale factor.G6320multiplied by expansion scale factor.G641sion scale factor.G65RCL 2nd INDmg $\leq 10^2$ stored. The digit in memory 00 is compared with t.G76 $=$ mg $\leq 10^2$ stored. The digit in memory 00 is compared with t.G77 $=$ mg $\leq 10^2$ stored. The digit in memory 00 is compared with t.G78RCLOOG79 $=$ mg $\leq 10^2$ stored. The digit in memory 00 is compared with t.G77 $=$ mg $\leq 10^2$ stored. The digit in memory 00 is compared with t.G78R/SIf the value is ≤ 18 is stopped.G79 0 $=$ G80STOMemory 39 is cleared.G81ColSTOG82STOSTOG83COMemory 39 is cleared.G84ColIf the value is < 18 beled.G83COSTMG84COSTMG85INVCla the cycle is repeated, stopped.G94COCG95INVCla the cycle is repeated, if $= 18$, is stopped.G962nd x=tCG97CStopped.G98R/SStopped.G99OStopped.G99CStopped.G91Stopped.G93CStopped.G94COStopped.G95Stopped	059	RCL 2nd IND	Net heights recal-
def*widths, divided by correction factors, multiplied by expan- sion scale factor.0632010641100065RCL 2nd INDmg $\$$ 10 ² stored. The digit in memory 00 is compared with t.070 \ddagger \blacksquare 071STO 2nd INDmg $\$$ 10 ² stored. The digit in memory 00 is compared with t.071STO 2nd INDmg $\$$ 10 ² stored. The digit in memory 00 is compared with t.073RCLcompared with t.07400If = 18 is stopped.075Znd x=t0 is set in the coun- ting memory.0790Memory 39 is cleared.080STOSUM083CC0842nd IADmg $\$$ 10 ² recalled, summed and stored.085CC0861Counting program.087CSUM088COSTO093AC094CStopped.095INVC is set in the coun- ting memory.096CC097CStopped.098R/SO109CStopped.101COThe fourth loop is la- beled.1022nd INDmg $\$$ 10 ⁴² recalled, di- vided by total mg $\$$ 103DThe fourth loop is la- beled.1041C105SUM106CO107RCL 2nd IND108CD109 <td>060</td> <td>00</td> <td>led, multiplied by</td>	060	00	led, multiplied by
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064::sion scale factor.065RCL 2nd IND66640067\$\$068RCLcompared with t.071STO 2nd INDng \$ 10 ² stored. The07200igit in memory 00 is073RCLcompared with t.07400If the value is $\angle 18$ 075INVif = 18 is stopped.0762nd x*tif = 18 is stopped.077B0078R/SMemory 39 is cleared.0790Memory 39 is cleared.081390082STO083390842nd IBI085C0861087SUM088CC089RCL 2nd IND0990001STO003RCL0040010100033R/S04400452nd x=t0562nd x=t057C058R/S0590051SUM0522nd bl103D053SUM1041105SUM106C107RCL 2nd IND10800109:101001022nd Eli113I11401150116=1172nd Pause<	063	20	multiplied by expan-
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CostCCDefed.Cost1Counting program.CostSUMCostSUMCostCounting program.CostSummed and stored.CostSummed and stored. <td>084</td> <td>224 121</td> <td>The third loop is las</td>	084	224 121	The third loop is las
CostCCounting program.CostSUMmg $#$ 10 ⁴² recalled,CostSUMsummed and stored.CostSUMsummed and stored.CostSUMSummed and stored.CostSUMSummed and stored.CostSUMSummed and stored.CostSUMSummed and stored.CostSummed	034		beled.
087SUM000088OO089RCL 2nd IND090OO091SUM09239093RCL094OO095INV0962nd x=t097C098R/S099O099O100STO101OO1022nd Lb1103D1041105SUM106OO107RCL 2nd IND108OO109:111391124113I114O115O116=1172nd Fix11821202nd Pause1212nd Pause1222nd Pause1232nd Pause	086	1	Counting program.
038 00 $mg \neq 10^{+2}$ recalled, summed and stored. 039 00 00 031 SUM $summed$ and stored. 032 39 The digit in memory. 00 is compared with t. If the value is C 034 00 t. If the value is C 034 00 t. If the value is C 035 INV $C18$ the cycle is repeated, if $z = 18$, is stopped. 096 $2nd x=t$ C $peated, if z = 18, isstopped.097CCC098R/S0 is set in the counting memory.000STOO is set in the counting memory.10100C1022nd Lb1D103DC1041C105SUMC10600recalled, diring memory.107RCL 2nd INDmg \neq 10^{+2} recalled, diring \neq 10^{+2} recalled, diring \neq 10^{+2}, multiplied by 100.1113910^{-2}, multiplied by 100.1113910^{-2}, multiplied by 100.116=1172nd Pause2nd Pause1202nd Pause1212nd Pause1222nd Pause1222nd Pause1212nd Pause1222nd Pause1222nd Pause1232nd Pause1242nd Pause1252nd Pause126$	087	SUM	councing program.
089RCL 2nd IND $mg # 10^{+2}$ recalled, summed and stored.09000SUM091SUM09239093RCL09400095INV0962nd x=t097C098R/S0990000STO100STO101001022nd Lb1103D1041105SUM1060107RCL 2nd IND10800109:110RCL11139112*113I11401150116=1172nd Fix11821202nd Pause1212nd Pause1222nd Pause	088	00	
09000summed and stored.091SUM09239093ECL0040009400095INV0962nd x=t097C098R/S0990000STO100STO101001022nd Lbl1041105SUM10600107RCL 2nd IND10800109:11139112*113I11401150116=1172nd Fix11821202nd Pause1212nd Pause1222nd Pause1232nd Pause	089	RCL 2nd IND	$mg \neq 10^{\pm 2}$ recalled,
091SUM09239The digit in memory093ECLOO is compared with094OO C 095INV $C18$ the cycle is repeated, if = 18, is0962nd x=tpeated, if = 18, is097CStopped.098R/SO is set in the counting memory.100STOO is set in the counting memory.101OOThe fourth loop is labeled.103DCounting program.1041Counting program.105SUMCounting program.106OOit of the counting set of the counting program.107RCL 2nd INDmg # 10 ^{t2} recalled, divided by total mg #109:102, multiplied by 100.11139102, multiplied by 100.115O116116=1172nd FixAminoscid percentage1182to 2 decimal places1202nd Pausedisplayed.1212nd Pausedisplayed.	090	00	summed and stored.
09239The digit in memory. OO is compared with t. If the value is093ECL OOOO is compared with t. If the value is095INV O is compared with t. If the value is0962nd x=t C <18 the cycle is repeated, if $= 18$, is stopped.097C O is set in the counting memory.098R/SO is set in the counting memory.099O O is set in the counting memory.100STO DO is set in the counting memory.101OOThe fourth loop is labeled.103DCounting program.1041 Counting program.105SUM OOCounting program.106OOmg # 10 ⁴² recalled, di- vided by total mg #107RCL 2nd IND RCLmg # 10 ⁴² recalled, di- vided by total mg #11139 t102, multiplied by 100.1124 t1113I t114O115O116= to 2 decimal places1172nd Fix t1202nd Pause1212nd Pause1222nd Pause1232nd Pause1242nd Pause1252nd Pause1262nd Pause1272nd Pause1282 to 2 decimal places1292nd Pause1202nd Pause1212nd Pause1222nd Pause1232nd Pause1242nd Pau	091	SUM	
093ECL00 is compared with094COt. If the value is095INVC0962nd x=tpeated, if = 18, is097Cstopped.098R/S0099O0100STO0 is set in the counting memory.101COThe fourth loop is labeled.1022nd LblThe fourth loop is labeled.103DCounting program.1041Counting program.105SUMmg # 10 ⁴² recalled, di-107RCL 2nd INDmg # 10 ⁴² recalled, di-108COi109:10 ² , multiplied by 100.1113910 ² , multiplied by 100.116=Aminoscid percentage1172nd FixAminoscid percentage1202nd Pausedisplayed.1212nd Pausedisplayed.	092	39	The digit in memory
09400t. If the value is095INV < 18 the cycle is repeated, if $\bar{r} = 18$, is0962nd x=tpeated, if $\bar{r} = 18$, is097Cstopped.098R/S0 is set in the counting memory.000STO0 is set in the counting memory.10100The fourth loop is labeled.103DCounting program.1041Counting program.105SUMmg # 10 ⁺² recalled, dirvided by total mg #10600is107RCL 2nd INDmg # 10 ⁺² recalled, dirvided by total mg #10800is109:10 ² , multiplied by 100.11139is112*10 ² , multiplied by 100.116=21172nd FixAminoscid percentage1202nd Pausedisplayed.1212nd Pauseisplayed.	093	RCL	00 is compared with
095INV $\zeta 18$ the cycle is repeated, if = 18, is0962nd x=tpeated, if = 18, is097Cstopped.098R/S0 is set in the counting memory.100ST00 is set in the counting memory.10100The fourth loop is labeled.103DCounting program.1041Counting program.105SUMCounting program.10600mg = 10 ⁺² recalled, diried by total mg = 10 ² , multiplied by 100.11139102, multiplied by 100.113I102, decimal places116=Aminoscid percentage1172nd FixAminoscid percentage1202nd Pausedisplayed.	094	00	t. If the value is
0962nd x=tpeated, if = 18, is097Cstopped.098R/S0 is set in the counting memory.100STO0 is set in the counting memory.101OOThe fourth loop is labeled.103DCounting program.1041Counting program.105SUMCounting program.106OOmg # 10 ⁺² recalled, di-107RCL 2nd INDmg # 10 ⁺² recalled, di-108OOit diabetee109:10 ² , multiplied by 100.1113910 ² , multiplied by 100.115O116116=1172nd FixAminoscid percentage1202nd Pausedisplayed.1212nd Pausedisplayed.	095	INV	<pre><18the cycle is re-</pre>
097Cstopped.098 \mathbb{R}/\mathbb{S} 0 is set in the counting memory.09900100 $\mathbb{ST0}$ \mathbb{C} 10100 \mathbb{C} 1022nd LblThe fourth loop is labeled.103D \mathbb{C} 1041 \mathbb{C} 105SUM \mathbb{C} 10600 $\mathbb{M} \neq 10^{+2}$ recalled, dirivided by total mg $\neq 10^{-12}$, multiplied by 100.109: 10^2 , multiplied by 100.11139 10^2 , multiplied by 100.112 \neq 10^2 , multiplied by 100.116= 117 1182 2 1202nd FixAminoscid percentage1212nd Pausedisplayed.	096	2nd x=t	peated, if = 18, is
098R/S0990100STO101001022nd Lbl103D1041105SUM10600107RCL 2nd IND10800109:11139112*113I11401150116=1172nd Fix11821202nd Pause1212nd Pause	097	c	stopped.
09900is set in the counting memory.100STOThe fourth loop is labeled.1022nd LblThe fourth loop is labeled.103DCounting program.1041Counting program.105SUMSUM106OOmg # 10 ⁺² recalled, dirvided by total mg #109:102, multiplied by 100.11139102, multiplied by 100.113II114OI115OI116=1172nd FixAminoscid percentage to 2 decimal places1202nd Pausedisplayed.1212nd PauseI	098	R/S	¥
100STO OOting memory.101OOThe fourth loop is la- beled.103DThe fourth loop is la- beled.1041Counting program.105SUM106OO107RCL 2nd IND108OO109:110RCL11139112*113I114O115O116=1172nd Fix11821202nd Pause1212nd Pause1222nd Pause	099	0	1 0 is set in the coun-
101001022nd Lbl103D1041105SUM10600107RCL 2nd IND10800109:110RCL11139112*113I11401150116=1172nd Fix11821202nd Pause1212nd Pause1222nd Pause	100	STO	ting memory.
1022nd Lb1The fourth loop is labled.103Dbeled.1041Counting program.105SUMCounting program.106OOmg \neq 10 ⁴² recalled, di-107RCL 2nd INDmg \neq 10 ⁴² recalled, di-108OOvided by total mg \approx 109:10 ² , multiplied by 100.1113910 ² , multiplied by 100.112 \approx 10 ² 113I1114O115115O116116=1172nd FixAminoscid percentage1182to 2 decimal places1202nd Pausedisplayed.1212nd Pause $=$ 1222nd Pause $=$	101	00	¥
103DCounting program.1041Counting program.105SUM 00 106 00 mg # 10 ⁺² recalled, dir107RCL 2nd INDmg # 10 ⁺² recalled, dir108 00 vided by total mg #109:10 ² , multiplied by 100.110RCL*11139112*113I11401150116=1172nd Fix11821202nd Pause1212nd Pause1222nd Pause1232nd Pause1242nd Pause1252nd Pause1262nd Pause1272nd Pause1282nd Pause1292nd Pause1202nd Pause1212nd Pause1222nd Pause	102	2nd Lb1	L beled.
105 SUM 106 00 107 RCL 2nd IND 018 00 109 : 110 RCL 111 39 112 * 113 I 116 = 117 2nd Fix 118 2 120 2nd Pause 121 2nd Pause 122 2nd Pause	103	1	Counting program.
106 ∞ $mg \neq 10^{+2}$ recalled, di-107RCL 2nd IND $mg \neq 10^{+2}$ recalled, di-018 ∞ $vided$ by total $mg \neq 10^{-1}$ 109: 10^{-2} , multiplied by 100.110RCL 10^{-2} , multiplied by 100.11139 10^{-2} , multiplied by 100.112* 10^{-2} , multiplied by 100.113I 10^{-2} , multiplied by 100.116= 117 1172nd FixAminoscid percentage1182to 2 decimal places1202nd Pausedisplayed.1212nd Pause 10^{-2} 1222nd Pause 10^{-2}	105	SITM	Program
107RCL 2nd IND $mg \neq 10^{+2}$ recalled, di-01800vided by total $mg \neq 10^{-2}$ 109: 10^{-2} , multiplied by 100.110RCL 10^{-2} , multiplied by 100.11139112112*113I11401150116=1172nd Fix11821192nd Pause1202nd Pause1212nd Pause1222nd Pause1232nd Pause1242nd Pause1252nd Pause1262nd Pause1272nd Pause1282nd Pause1292nd Pause1202nd Pause1212nd Pause1222nd Pause1232nd Pause1242nd Pause1252nd Pause1262nd Pause1272nd Pause1282nd Pause1292nd Pause1202nd Pause1212nd Pause1222nd Pause1232nd Pause1242nd Pause1252nd Pause1262nd Pause1272nd Pause1282nd Pause1292nd Pause1202nd Pause1212nd Pause1222nd Pause1232nd Pause1242nd Pause1252nd Pause1262nd Pause	106	00	₩
01800vided by total mg *109:102, multiplied by 100.110RCL102, multiplied by 100.11139112112*113I11401150116=1172nd Fix11821192nd Pause1202nd Pause1212nd Pause1222nd Pause	107	RCL 2nd IND	mg # 10 ⁺² recalled. di-
109:102, multiplied by 100.110RCL11139112*113I11401150116=1172nd Fix11821192nd Pause1202nd Pause1212nd Pause1222nd Pause	018	00	vided by total mg *
110 RCL 111 39 112 4 113 I 114 0 115 0 116 = 117 2nd Fix 118 2 120 2nd Pause 121 2nd Pause 122 2nd Pause	109	:	10 ² , multiplied by 100.
111 39 112 * 113 I 114 O 115 O 116 = 117 2nd Fix 118 2 119 2nd Pause 120 2nd Pause 121 2nd Pause 122 2nd Pause	110	RCL	
112 * 113 I 114 O 115 O 116 = 117 2nd Fix 118 2 119 2nd Pause 120 2nd Pause 121 2nd Pause 122 2nd Pause	111	39	
113 I 114 O 115 O 116 = 117 2nd Fix 118 2 119 2nd Pause 120 2nd Pause 121 2nd Pause 122 2nd Pause	112	*	
114 0 115 0 116 = 117 2nd Fix 118 2 119 2nd Pause 120 2nd Pause 121 2nd Pause 122 2nd Pause	113	I	
115 0 116 = 117 2nd Fix 118 2 119 2nd Pause 120 2nd Pause 121 2nd Pause 122 2nd Pause	114	0	
110 = 117 2nd Fix Aminoscid percentage 118 2 to 2 decimal places 119 2nd Pause displayed. 120 2nd Pause displayed. 121 2nd Pause displayed.	115	0	
If and Fix Amino scila percentage 118 2 119 2nd Pause 120 2nd Pause 121 2nd Pause 122 2nd Pause	115	2003 544	Imino rold - or rotate
110 2nd Pause displayed. 120 2nd Pause 121 2nd Pause 122 2nd Pause	440	211G ETZ	to 2 decimal place
120 2nd Pause 121 2nd Pause 122 2nd Pause	110	2nd Pance	displayed
121 2nd Pause 122 2nd Pause	120	2nd Pause	arshralea.
122 2nd Pause	121	2nd Pause	
	122	2nd Pause	*
	<u> </u>		-

(Continued on p. 74)

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TABLE II (continued)

Program steps	Key	Comments
123	RCL 2nd IND	ng # 10 ⁺² recalled
124	00	and divided by dayler.
125	=	
126	RCL	
127	59	
128	=	
129	2nd Fix	Results to integer
130	0	displayed.
131	2nd Pause	
132	2nd Pause	
133	2nd Pause	
134	2nd Pause	V
135	RCL	The digit in memory
136	00	00 is compared with
137	INV	t. If the value is
138	2nd x=t	<18 the cycle is re-
139	Ð	peated, if = 18 is
140	R/S	stopped.

TABLE III

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PROGRAM FOR THE CALCULATION OF CORRECTION FACTORS

Program steps	Key	Comments
000-038	The same	as in the main program
039	0	Value for counting
040	STO	program are set.
041	00	
042	2	
043	0	
044	STO	
045	20	
046	4	
047	0	
048	STU	
049	40 2-3 7-3	W The second loss is
050	Tug Tot	The second 1005 is
051	3	
052	± 5774	Counting program.
053	5011	
055	CTD4	
055	20	
057	SEM	
058	40	*
059	RCL 2nd IND	Net heights recalled.
060	00	multiplied by widths.
061	#	multiplied by 10000 and
062	RCL 2nd IND	divided by nanomoles
063	20	of each aa/ml of cali-
064	÷	bration mixture (=40),
065	4	divided by molecular
066	0	weights, multiplied by
057	:	expansion scale factor.
068	RCL 2nd IND	
069	40	
070	*	
071	RCL	
072	19	
073	=	•
074	STO 2nd IND	Correction factor to
075	40	2 decimal places sto-
076	2nd Fix	V red.
077	2	The digit in memory ou
078	RCL	is compared with t. II
079	00	the value 15 < 10, the
030	INV 2-2	cycle is repeated, if
081	2na x=t	- tot ta proffere
002	5	1
	ry 5	· · · · · · · · · · · · · · · · · · ·

NOTES

addition, if the printing device PC100 is available, the program itself and partial or final results can be printed. Thus, by avoiding any break in the program to write down the data, the time needed to process data is further reduced.

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