Secretion and Distribution of Iodine-131 in Milk from Dairy Cow after Intravenous Administration of a Single Dose

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Experiment was carried out in order to know the distribution of ^{131}I in milk and the secretion into milk from lactating Holstein cows after a single intravenous administration. It was recognized that about 26% and 61% of dosed ^{131}I was recovered during the 6 days following administration from milk of Holstein (A) and (B) respectively.

About 2% and 20% of ^{131}I were found in fat and protein fractions respectively and no regular variation was observed on the distribution pattern as a function of time after administration.

From those considerations it was concluded that Glascock's assumption would be acceptable and consequently the composite system of ion exchange treatment and CCl_4 extraction would be also acceptable as a rapid and convenient method for the determination of ^{131}I in milk previously recommended by the authors.

1. Introduction

In previous report⁽¹⁾, ion exchange treatment followed by CCl_4 extraction was recommended as a rapid method for the determination of ^{131}I in milk. Only an ionic form of iodine could be determined by this method. If the percentage of it is not so variable as suggested by Glascock⁽²⁾, it will be accepted as a rapid and convenient one. Because of the requirement to establish his suggestion, this experiment was carried out in order to know the distribution of ^{131}I in milk and also the secretion of it into milk from lactating Holstein cows after intravenous administration of a single dose.

2. Procedure

2.1 Cows

Two lactating Holstein cows were used. As a preliminary breeding, they were kept in a room, specially designed for a tracer experiment, for about two weeks before administration. In advance, the milk properties such as gravity, pH, acidity, chlorine and lactose contents, and alcohol test were examined in accordance with a usual analytical procedure⁽³⁾.

2.2 Preparation of the stock solution and

administration

Original Na^{131}I solution was diluted with 10 ml of physiological solution of sodium chloride (no carrier was added). Eight ml (2 mCi) and three ml (0.75 mCi) of the solution were injected to each cow intravenously.

2.3 Milking, fractionation and measurement

Milking was done twice a day in the morning and in the evening. In every milking time, total quantity of the secreted milk and the activity were checked. Fat, protein and whey were separated from every milk and counted. Fat was separated by Roesse-Gottlieb method⁽³⁾. Protein was separated by following

Table 1 General analysis of milk

Milk comes from Items	Holstein (A)	Holstein (B)	Normal milk ⁽⁵⁾
Gravity	1.031	1.030	1.027-1.035
Acidity(%)	0.11	0.15	0.15-0.18
Chlorine(%)	0.19	0.11	less than 0.12
Lactose(%)	4.11	4.57	4.50
Alcohol test	(—)	(—)	(—)

Note: Mastitis or abnormal milk often shows high pH (more than 6.8), high acidity (more than 0.18%), high chlorine content (more than 0.12%), high chlorine-lactose number* (more than 4.00) and (+) of alcohol test.

* Chlorine-lactose number: $\text{chlorine}(\%) \times 100/\text{lactose}(\%)$.

four ways:

- a) by addition of rennet,
 - b) by addition of 1 N HCl solution,
 - c) by addition of 17% of TCA solution (trichloroacetic acid)
 - and d) by ultra high speed centrifugation.
- After separation, the radioactivity of the separated whey was measured. Iodine-131 in protein was calculated by subtracting the activities of whey and fat from that of the whole milk used.

3. Results and Discussions

The milk properties examined in advance were shown in Table 1. High pH, high chlorine and low lactose contents of milk from Holstein (A) suspected that the milk should be mastitis milk, on the other hand, the low acidity and alcohol test (—) suggested that it might be normal. Anyway it was considered that Holstein (A) was under suspicion of mastitis and therefore chlorotetracycline was

Table 2 The secretion of ^{131}I into milk

Cow	Date of milking	Quantity of secreted milk (kg)	Concentration of ^{131}I (μCi)	Percentage* secretion of ^{131}I	Cumulative percentage secretion
Holstein (A)	25 Oct. (E)**	6.0	14.58	4.6	4.6
	26 (M)***	12.6	9.36	6.2	10.8
	26 (E)	4.9	9.54	2.5	13.3
	27 (M)	11.1	6.60	3.8	17.1
	27 (E)	5.0	6.58	1.7	18.8
	28 (M)	10.4	3.81	2.1	20.9
	28 (E)	5.0	4.30	1.1	22.0
	29 (M)	12.2	2.11	1.4	23.4
	29 (E)	4.8	2.27	0.6	24.0
	30 (M)	11.4	1.72	1.0	25.0
	30 (E)	4.1	2.06	0.4	25.4
	31 (M)	10.7	1.22	0.7	26.1
	31 (E)	5.3	1.32	0.4	26.5
	1 Nov. (M)	10.6	0.84	0.5	27.0
	1 (E)	4.6	0.91	0.2	27.2
	2 (M)	11.6	0.72	0.4	27.6
	2 (E)	5.0	0.80	0.2	27.8
	3 (M)	10.5	0.56	0.3	28.1
	3 (E)	6.7	0.68	0.2	28.3
Holstein (B)	23 Nov. (E)	3.0	16.57	11.4	11.4
	24 (M)	9.3	8.64	18.4	29.8
	24 (E)	4.7	6.15	6.6	36.4
	25 (M)	10.7	3.93	9.6	46.0
	25 (E)	4.1	3.44	3.2	49.2
	26 (M)	9.7	2.31	5.1	54.3
	26 (E)	4.2	1.56	1.5	55.8
	27 (M)	10.6	0.93	2.2	58.0
	27 (E)	3.7	0.72	0.6	58.6
	28 (M)	10.6	0.51	1.2	59.8
	28 (E)	3.8	0.38	0.3	60.1
	29 (M)	10.7	0.29	0.7	60.8

* Secreted $^{131}\text{I} \times 100 / \text{administered } ^{131}\text{I}$

** Evening

*** Morning

administered to it. Table 2 shows the secretion of ^{131}I into milk.

The highest concentration of ^{131}I shown as $^{131}\text{I}_{\mu\text{Ci/l}}$ of milk was observed four hours after intravenous administration. This suggested that the transfer velocity from blood to milk was considerably fast. The quantity of the morning milk was generally more than that of the evening milk, but the concentration of ^{131}I was higher in the evening milk than in the morning milk, presumably caused by the difference of the milking interval. Maximum secretion of ^{131}I was observed on the second day after administration.

About 26% and 61% of ^{131}I were recovered during the 6 days following a single intravenous administration from Holstein (A) and Holstein (B) respectively. Those are considerably high compared with 1.3 to 13.1% (mean: 5%) recovery from milk of cows during the 6 days following a single oral dose reported by Garner⁴⁾. In this case of oral administration, high percentage of ^{131}I should be excreted directly to feces to result in less percentage-transference to milk. Iodine absorbed by cows

is deposited mainly in thyroid gland which is the critical organ for ^{131}I . It is said that the transfer rate of dosed ^{131}I to thyroid gland can be influenced by the level of stable iodine in blood, consequently by the amount of stable iodine in feed. And it is conjectured that the secretion rate of ^{131}I to milk may be fluctuated against the variation of the transfer rate of ^{131}I to thyroid gland. This suggests that the saturation of thyroid gland with stable iodine may cause the decrease of the transfer rate of dosed ^{131}I to thyroid gland, and consequently the increase of ^{131}I to milk. High recovery of ^{131}I obtained may be due to an intravenous administration and also partially due to the reason mentioned above because cows were fed by the formula feed containing 5% of fish meal whose iodine content should be high. Table 3 shows the distribution of ^{131}I in milk. Only two percent of iodine was found in fat fraction. Percentage of the distribution to protein, which was somewhat variable by the method of the separation, was about 20% as shown in Table 3. Ultra high speed centrifugation showed the considerably low concentration

Table 3 Distribution of ^{131}I in milk collected in the morning

Cows	Date of milking	Percentage of distribution				
		Fat fraction	Protein fraction separated by			
			rennet	1N HCl	TCA	UHC*
Holstein(A)	26 Oct.	0	27	16	27	2
	27	0	21	25	17	3
	28	0	17	20	19	
	29	5	34	25	16	
	30	1	33	22	31	
	31	7	28	20	30	
	Average	2	27	21	23	3
Holstein(B)	24 Nov.	0	19	22	13	4
	25	1	24	21	—	8
	26	5	31	22	19	
	27	0	28	19	12	
	Average	2	26	21	15	6
Total average		2	26	21	20	4
Standard deviation			6	3	7	

Remark: Each value contains at least 15% errors.

* Ultra high speed centrifugation.

of ^{131}I , suggesting the imperfect separation of protein. Protein fraction separated by rennet showed a little high concentration of ^{131}I , presumably caused by intermixture of whey, because the volume of the protein was somewhat more than that of protein coagulated by 1 N HCl and 17% TCA. From those considerations it was estimated that about 20% of ^{131}I combined with protein.

Because of the short half life of ^{131}I , it is not necessary to consider the contamination of ^{131}I into milk products such as butter and cheese. But in case of ^{129}I , the contamination of it into milk products cannot be always ignored because of the long half life of 1.7×10^7 years. As mentioned above, in that case, nearly 30% of ^{129}I should be contained in cheese, because cheese is coagulated mostly by rennet.

No regular variation was observed on the distribution pattern as a function of time after administration.

It was concluded that Glascock's assumption would be supported through those experiments and consequently the composite system of ion exchange treatment and CCl_4 extraction would be acceptable as a rapid and convenient method for the determination of ^{131}I in milk previously recommended by the authors.

4. Conclusion

Experiment was carried out in order to know the distribution of ^{131}I in milk and the secretion into milk from lactating Holstein cows after a single intravenous administration. It was recognized that about 26% and 61% of dosed ^{131}I was recovered during the 6 days

following administration from milk of Holstein (A) and (B) respectively.

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要 旨

静脈内投与した ^{131}I の乳汁への分泌ならびに乳における分布

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静脈内投与した ^{131}I の乳汁への分泌ならびに乳における分布について検討した。乳牛としてはホルシュタイン牛2頭を用い、 Na^{131}I を静脈内に1回投与した。投与後6日間に、乳中に分泌された ^{131}I の量は、投与量のそれぞれ26%および61%であった。乳中に分泌された ^{131}I のうち約2%が脂肪区分に、約20%がタンパク区分に見出された。牛乳中の ^{131}I の分布状態については、投与後の経時的規則的変動は見出されなかった。本実験により、Glascockの仮説が支持され、著者らが以前本紙に投稿した牛乳中の ^{131}I の迅速定量法が、実用に供しうることが判明した。