3. The Vitamin A Contents of the Livers of Sheep, Cattle and Pigs

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The large amount of vitamin A in the livers of farm animals was reported by Rosenheim & Webster [1926], and additional data have since been included in many communications. No systematic inquiry, however, has hitherto been made in this country with a view to establishing typical values for liver as bought from the butcher. The present work was undertaken to obtain information on the subject.

Experimental

Fresh specimens of liver were obtained through the kindness of Mr J. A. Powell of the Cambridge Co-operative Society. The first series of estimations was done between 26 March and 2 April 1941, which was before the growth of new grass. A second series was carried out between 9 and 18 September, after green pasture had been available continuously throughout the summer.

Vitamin A was estimated by the SbCl_3 method after the extraction of the liver fat by digestion with alkali [Davies, 1933]. To convert blue units into i.u. a factor of 0.6 was used [Moore, 1937]. Carotene was virtually absent from sheep and pig livers, but was estimated by the Zeiss photometer in selected bovine specimens. Even in these the contribution of carotene to the total vitamin A activity was usually small. Values were not corrected individually for the presence of carotene, but a correction corresponding to the mean of the two extreme values for each group was added to the mean for preformed vitamin A.

Table 1. *The vitamin A content of liver*

Animal	Type	Age years	Winter (March-April) vitamin A, i.u./g. liver	Mean vitamin A for group, WINTER	Type	Age	Summer (September) vitamin A, i.u./g. liver	Mean vitamin A for group, SUMMER
SHEEP	Young	1-2	300	Sheep 450	Young	10 months	210	Sheep 468
		"	300			10 "	375	
		"	300			10 "	375	
		"	450			10 "	600	
		"	450			10 "	825	
		"	525			18 "	190	
		"	525			18 "	375	
		"	525			18 "	375	
		"	525			2½ years	675	
		"	600			2½ "	675	
BEEF animals	Steers	2	15		Steers	1 year	17	Mean 117
		2	25			3 years	105	
		2-3	18			4 "	105	
		2-3	30			4 "	105	
		2-3	30			4 "	205	
		2-3	75			5 "	75	
		3	21			5 "	75	
		3	13			5 "	250	
		4	6					
		4	36					
		?	110					
			Mean 34					

Table 1 (cont.)

Animal	Type	Age years	Winter (March-April) vitamin A, i.u./g. liver	Mean vitamin A for group, WINTER All beef animals except calves	Type	Age	Summer (September) vitamin A, i.u./g. liver	Mean vitamin A for group, SUMMER All beef animals except calves
	Heifers*	2½	30	83	Heifers*	1 year	75	151
		4	19†			4 years	185†	
		4	120			4 "	375	
			Mean 56				Mean 212	
	Cows	4½	450		Cows	5 "	36	
		5	53			5 "	105	
		5	150			5 "	125	
		5	165			5 "	150	
		5	225			5 "	250	
			Mean 210			5 "	300	
							Mean 161	
					Bull	4 "	187	
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CALVES	Months				Up to	3 days	20	
	2-3	0.6			1 month	3 "	50	
	"	3			old	10 "	54	
	"	6		Calves	14 "	14		
	"	6		11	3 weeks	33		All calves
	"	14			1 month	37		63
	"	15				Mean 35		
	"	18			Over	2 months	37§	
	"	18			1 month	2 "	27	
	"	21			old	2 "	110	
						3½ "	24	
						3½ "	33	
						4 "	54	
						4 "	60	
						4 "	75	
						6 "	150	
						6 "	225	
						Mean 80		
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Pigs	Young	6-8	0		Pigs	6 "	14	
		"	5			6 "	27	
		"	5				Mean 20	
		"	5					
		"	6	Young pigs	Boars	6 "	75	All pigs
		"	6	12		6 "	75	76
		"	7				Mean 75	
		"	18					
		"	30		Sows	3 years	45	
		"	36			3 "	67	
						3½ "	90	
						3½ "	100	
						5 "	150	
						5 "	150	
						Mean 100		

* The term 'heifer' as used locally includes cows which have lactated once only.

† 3-10 i.u. as carotene. ‡ 16-88 i.u. as carotene. § 0-6 i.u. as carotene.

The reduction of 0.07 i.u. of preformed vitamin for every i.u. of carotene, which must be made to allow for the blue colour contributed by carotene in the SbCl_3 test, was usually very small.

The data obtained are given in Table 1.

Discussion

Mean values for the vitamin A content of specimens of liver collected during March–April ('winter') and September ('summer') are summarized in Table 2. A simple mean of the summer and winter values has been taken to provide convenient single values for each animal.

Table 2. *Summary of the mean vitamin A contents of the livers of different animals*

	Combined vitamin A and carotene contents, I.U./g. liver				Combined vitamin A and carotene contents, I.U./g. liver		
	Winter	Summer	Mean of winter and summer		Winter	Summer	Mean of winter and summer
Sheep	450	468	459	Calves	11	66	39
Beef animals	89	198	144	Pigs	12	78	45

Livers of sheep (winter and summer mean, 459 I.U./g.) were much richer than those of adult cattle (144 I.U.) which were in turn richer than those of the pig (45 I.U.) and calf (39 I.U.). It is not surprising that the vitamin A content of calf liver should be low, since in all mammals so far examined the amount of vitamin A which is transferred to the embryo is small in comparison with the reserves present in the liver of the mother. Dunlop [1934] has shown that the diets used in rearing pigs are often low in vitamin A, which no doubt explains the low vitamin content of their liver. The cause of the superiority of sheep liver over the liver of adult cattle is more obscure. It is clear that in cows having free access to grass the amounts of vitamin A secreted in the milk and stored in the liver represent only a very small fraction of the carotene ingested [Moore, 1932]. Possibly the superiority of the liver of sheep may be due to their more efficient utilization of carotene, which may also be the cause of the almost complete absence of carotene from the fat depots. It must be remembered also that concentrates and turnip roots, which are low in carotene, are given much more liberally to cattle than to sheep.

Seasonal variation. No seasonal variation was found with sheep. The summer means for steers, calves and pigs were some 4–6 times greater than the winter ones. To some extent, particularly with pigs, the greater age of some of the animals at slaughter may have been partly responsible for the increased reserves in summer.

SUMMARY

1. The vitamin A in specimens of liver collected at a local butcher's shop was estimated by the SbCl_3 method.
2. The means of values obtained in summer and winter were: sheep liver 459 I.U./g., beef liver 144 I.U., calf liver 39 I.U. and pig liver 45 I.U.
3. The livers of cattle and pigs were usually richer in vitamin A in summer than in winter, but no difference was found with sheep.

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