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The Pantothenic Acid Content of Royal Jelly.*

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Considerable effort has been made to explain the physiological actors responsible for the development of one female larva of the oney-bee *(Apis mellifera L.)* into a worker while another becomes queen. The queens and workers are produced from identical ırvae, as it is possible to rear queens from any female larvae less han 3 days old by providing them with the proper food. For the ırst 2 days after hatching all female larvae receive a diet of royal elly, a secretion of the pharyngeal glands of the workers.[1] During he third day the diet of the larvae that are to become workers is hanged while the queen caste continues to receive royal jelly. This lifference in diet appears to be responsible for the morphological and unctional differences between the two castes.

Royal jelly has been assayed for various vitamins with the idea hat its phenomenal properties may be accounted for by the presence ›f liberal amounts of one or more of these growth factors. Experinents were conducted by Hill and Burdett[2] which lead them to :onclude that the worker bees add vitamin E to the royal jelly but vithhold it from the food of the worker larvae. It has since been ihown[3-6] that there are only negligible amounts of vitamin E present n royal jelly. According to Melampy and Jones[7] royal jelly con:ains no demonstrable amounts of vitamins A and C. Using the rat :urative method Haydak and Palmer[8] found that royal jelly contains ıpproximately 9 μg of thiamin per g of dry material. The phe-

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1 Snodgrass, R. E., *Anatomy and Physiology of the Honeybee,* New York, McGraw-Hill Book Co., 1925, p. 174.

2 Hill, L., and Burdett, E. F., *Nature,* 1932, **130**, 540.

3 Schoorl, P., *Z. Vitaminforsch.,* 1936, **5**, 246.

4 Mason, K. E., and Melampy, R. M., Proc. Soc. Exp. Biol. and Med., 1936, **35**, 459.

5 Evans, H. M., Emerson, G. A., and Eckert, J. E., *J. Econ. Ent.,* 1937, **30**, 642.

6 Haydak, M. H., and Palmer, L. S., *J. Econ. Ent.,* 1938, **31**, 576.

7 Melampy, R. M., and Jones, D. B., Proc. Soc. Exp. Biol. and Med., 1939, **41**, 382.

8 Haydak, M. H., and Palmer, L. S., *J. Econ. Ent.,* 1940, **33**, 396.

nomenal properties of royal jelly in developing queen bees can hardly be attributed to vitamins in it that have heretofore been studied.

The rat assay methods for the determination of vitamins in royal jelly leaves much to be desired. The quantity of royal jelly obtainable is sufficient for the use of only a limited number of animals. For most assays it is necessary to pool the royal jelly from several colonies to have sufficient for the assay. These difficulties are obviated by microbiological methods of assay.

The universal distribution of pantothenic acid in animal tissues and its biological importance which has been reviewed by Williams[9] prompted us to study the pantothenic acid content of royal jelly. Assays for pantothenic acid were made on fresh royal jelly by the microbiological method.[10] The moisture content was determined on each sample of royal jelly so as to permit expressing the pantothenic acid on both the fresh and dry basis. The samples of royal jelly from the same colony were secured at different times and from different cells after the colony had been dequeened.

From the data in Table I it is seen that royal jelly contains an

TABLE I.
Pantothenic Acid Content of Royal Jelly.

Sample No.	Colony No.	Moisture, %	Dry matter, %	Pantothenic acid	
				Fresh, μg/g	Dry, μg/g
1	I	63.8	36.2	142	392
2	I	67.5	32.5	140	431
3	I	61.1	38.9	147	378
4	II	62.1	37.9	215	567
5	II	62.8	37.2	230	618
6	III	66.5	33.5	205	612
7	III	65.5	34.5	200	580
	Avg	64.2	35.8	183	511

average of 183 μg of pantothenic acid per g on a fresh basis and 511 μg per g on a dry basis. This is considerably higher than for any other known material. Yeast and liver are 2 of the richest known sources of pantothenic acid. According to Jukes[11] dried brewers' yeast contains an average of 200 μg and liver 180 μg per g. On this basis the pantothenic acid content of royal jelly is more than 2.5 times that of yeast. Using the microbiological assay, Strong,

9 Williams, R. J., *Biol. Rev.*, 1941, **16**, 49.

10 Pennington, D., Snell, E. E., and Williams, R. J., *J. Biol. Chem.*, 1940, **135**, 213.

11 Jukes, T. H., *J. Nutrition*, 1941, **21**, 193.

et al.,[12] reported substantially lower values for yeast and liver than those found by Jukes with chick assay method. Thus, when the comparison is made with values obtained by the microbiological method the ratio of pantothenic acid in royal jelly to that of yeast is approximately 6 to 1.

Of the vitamins studied in royal jelly pantothenic acid is the only one in which it is unusually rich. Whether or not pantothenic acid is in any way responsible for the development of female larvae into queen bees remains to be studied. The presence of pantothenic acid in such relatively large amounts does suggest that it might be one of the factors responsible for the development into queens of the female larvae which continue to receive royal jelly.

Summary. It has been found that royal jelly is the richest known source of pantothenic acid. On a dry basis it contains an average of 511 μg per g which is between 2.5 and 6 times as much pantothenic acid as is present in yeast or liver.

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Influence of Age on Survival of Respiration, Spinal Reflexes, Pupillary Responses and Heart Action.

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Despite the many observations reported on survival of tissues and organs, little information is available concerning the influence of age on survival time. Several observers[1-5] have reported that young animals are more resistant to anoxia and asphyxia than are adults, and Selle and Witten[6] found that the primitive respiratory mechanism

12 Strong, F. M., Feeney, R. F., and Earle, Ann, *Ind. Eng. Chem., Anal. Ed.*, 1941, **13**, 566.

1 Reiss, M., and Haurowitz, F., *Klin. Wchnschr.*, 1929, **8**, 743.

2 Avery, R. C., and Johlin, J. M., PROC. SOC. EXP. BIOL. AND MED., 1932, **29**, 1184.

3 Kabat, H., and Dennis, C., PROC. SOC. EXP. BIOL. AND MED., 1939, **42**, 534.

4 Selle, W. A., and Witten, T. A., *Proc. Am. Physiol. Soc.*, 1941, **58**, 253.

5 Himwich, N. E., Alexander, F. A. D., and Fazekas, J. F., *Proc. Am. Physiol. Soc.*, 1941, **58**, 193.

6 Selle, W. A., and Witten, T. A., PROC. SOC. EXP. BIOL. AND MED., 1941, **47**, 495.