venience and of improving the conditions for regulating the comparison between the substances under test.

Using rats in which shock of the tourniquet type was produced by a slight adaptation of a technique described by Haist and Hamilton[2] we have found that most of these conditions can be met. The present report deals with rat plasma, 4 per cent. solutions in 0.85 per cent. saline of isinglass[3] and of polyvinyl alcohol (Type RH623 E. I. du Pont de Nemours and Company) and of 0.85 per cent. saline alone.

Ten 224–250 gm rats were used each day. Two served as controls while the remaining eight rats were divided into groups of two, each group receiving one of the solutions to be tested. A metal tourniquet which could be tightened to exert a constant pressure, was applied high on the thighs of both hind legs for five hours. Transfusion through a cannula in the right jugular vein was started forty-five minutes after release of the tourniquets. Ten cc of solution were injected into each rat at a rate of 2-2.1 cc per hour. Pentothal sodium (0.3 cc, 1 per cent. solution per 100 gm of rat given intraperitoneally) was given to permit cannulation. The anesthesia was light enough so that the effects wore off a few minutes after the cannulation was completed. Apart from this no anesthetic was used or was considered desirable for any reason throughout the experiment. Except for the 10 to 15 minutes used for the cannulation the animals were kept in thermostatically controlled warming cabinets at a temperature of 27–28° C.

The first 27 rats received unsterilized solutions. Thereafter the saline and isinglass solutions were autoclaved and the plasma and polyvinyl alcohol solution were passed through a Seitz filter. The plasma was prepared the same day as it was used from blood obtained by exsanguinating etherized rats through the carotid artery. About 10 units of heparin per cc of blood were used as an anticoagulant. The plasma was allowed to stand for several hours in the ice box and then centrifuged to remove any precipitate which had formed. The filtration was performed about two hours before the injection was started.

The results are set forth in Table 1.

TABLE 1

SURVIVAL RATES IN RATS TREATED FOR SHOCK

Substances tested	No. of animals	No. survived	Per cent. survived	Average survival time of the remainder in hours
Plasma	20	5	25	12 (range 2–38)
Saline	20	8	40	14 (range 3–33)
Isinglass	20	5	25	14 (range 2–31)
Polyvinyl alcohol	20	13	65	10 (range 4–20)
Control	25	2	8	10 (range 2–23)

Rats living more than 48 hours after the shock was initiated are considered to have "survived."

The effectiveness of polyvinyl alcohol is striking. The preparation used in this work (RH 623) has an approximate viscosity in 4 per cent. aqueous solution of 5 centipoises at 20° C. The molecular size has not been accurately worked out. Using preparation RH 391, a polyvinyl alcohol with a viscosity of 55 centipoises under the same conditions and therefore with a different molecular size, Heuper *et al.*[4] report many undesirable side effects following its parenteral administration in experimental animals. Although the toxic effects of RH 623 may be similar to those of RH 391 this should not be assumed on the basis of the work with RH 391 alone. For this reason we have undertaken to determine the toxicity of RH 623 separately. At any rate the fact that RH 623 is so effective for the immediate treatment of shock, is most interesting.

The relatively low survival rate in the group receiving plasma is worthy of comment. In accord with the findings reported here Allen[1] and Rosenthal[5] have found saline more effective than homologous plasma or serum in treating tourniquet shock in rats and mice. On the other hand, Mylon, Winternitz and de Süto-Nagy[6] working with dogs in tourniquet shock, report a 10 per cent. recovery with saline and a 76 per cent. recovery with citrated plasma. In a recent paper Green[7] states that homologous plasma did not decrease significantly the mortality in rats in tourniquet shock. It is apparent that the rating of plasma in the treatment of tourniquet shock is not clearly established.

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ASSOCIATIVE DYNAMIC EFFECTS OF PROTEIN, CARBOHYDRATE AND FAT

IN spite of published evidence warranting a different understanding, a general belief still prevails

[2] R. E. Haist and J. Hamilton. In press (personal communication).

[3] Kindly supplied by Professor N. B. Taylor, department of physiology, University of Toronto.

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that the specific dynamic effects of individual nutrients are significant with reference to normal, mixed diets and that the relatively high dynamic effect of protein dominates heat production in nutritive practice.

The facts in this relation are of special present importance because of the critical situation of nutrition throughout the world; because of a characteristic rôle of fat in connection with the utilization of nutritive energy; because of the need for fat in the manufacture of explosives; and because of the increased efficiency with which fat is "skimmed off" in manufacturing processes from which by-product feeding stuffs are derived.

Significant in this connection is a series of respiration experiments conducted with albino rats as subjects, in which were determined the specific dynamic effects of protein, carbohydrate and fat, singly and in the four possible combinations of these three kinds of nutriment; all such determinations being made in

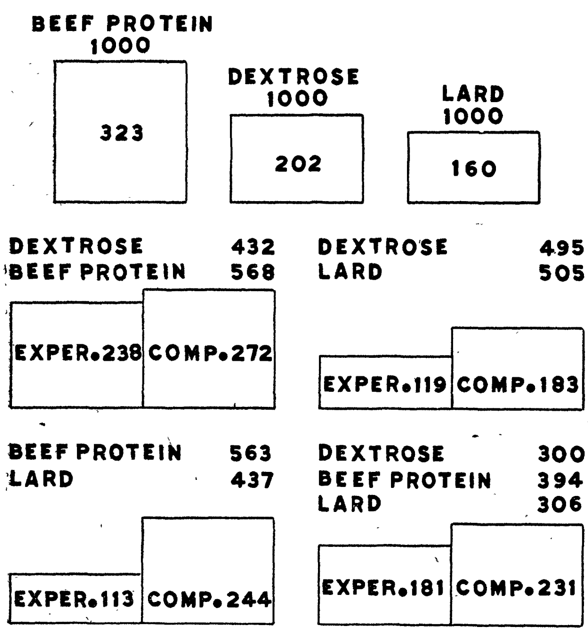

FIG. 1. Dynamic effects per thousand calories of gross energy of nutrients as affected by nutrient combination. Graph explained in text.

comparatively long-time experiments with the heat production from complete basal diets sufficient for maintenance as the base values.

Twelve rats of exactly the same age were used as the subjects of each determination, the dynamic effects being measured as the difference in heat production from the basal and the supplemented diets as observed for each dietary treatment during seven-hour experimental periods on two consecutive days, the observations on the supplemented diets being made seven days after those on the basal diets.

In Fig. 1 are presented values for the dynamic effects per 1,000 calories of gross energy of the individual nutritive supplements, and similar values for the four mixed supplements (1) as directly determined and (2) as computed from the values for their individual components.

The values above the rectangles represent in each case 1,000 calories of gross energy of the individual or of the combined nutrients, and the values inside the rectangles represent the dynamic effects of these substances fed as supplements to the basal diet.

The dynamic effects of the mixed supplements following the abbreviation, "Exper.," were as determined by experiment, while those following the abbreviation, "Comp.," were computed from the experimentally determined values for the individual components; the extent to which the determined were smaller than the computed values expressing the extent to which the association of nutrients resulted in decreased energy expense of utilization.

The separately determined dynamic effects of beef protein, dextrose and lard being 32 per cent., 20 per cent. and 16 per cent., respectively, of their gross energy values, the dynamic effects of the combination of dextrose and protein was 12.5 per cent. less, of dextrose, protein and lard 22 per cent. less, of dextrose and lard 35 per cent. less, and of protein and lard 54 per cent. less, than as computed from the dynamic effects of the individual nutrients.

Lard was much more potent than was beef protein in determining dynamic effects of nutrient mixtures. It conferred economy of utilization upon the nutrient combinations in which it was present.

The dynamic effects of diets, therefore, are not the additive dynamic effects of their components, and are not dominated by their protein contents; and inasmuch as there is no means of distributive assignment of the energy values of diets among their components, there are no significant standard dynamic effects of individual nutrients.

The results of this study suggest no special reason for decreasing the protein content of diets for hot weather, but rather that any desired decrease in dynamic effect because of hot weather should be accomplished by diminishing first the carbohydrate, second the protein and last the fat of the diet.

Also the results of this study imply that manufacturing processes which decrease the fat content of by-product feeds serve to lower the net energy value of the products not only through diminishing their gross energy but also by increasing the energy expense of their utilization.

That the protein contents of diets do not dominate the heat increment is also shown by five series of experiments conducted at this laboratory (Forbes, *et al.*, *Jour. Nutr.*, 10 (1935), 461; 15 (1938), 285; 18 (1939), 47; 20 (1940), 47), with mature as well as with growing rats as subjects, in which the heat production of animals receiving equicaloric diets differing in protein content decreased slightly in the order of the increase in protein.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE CHEMICAL CONTROL OF BERMUDA GRASS AND OF CROWFOOT GRASS

SODIUM CHLORATE[1, 2] and cyanamide[3] have been suggested for an eradication of Bermuda grass (*Cynodon dactylon* Pers.). The compounds have been used with a varying degree of success.[4] Experiments with other herbicides seemed therefore indicated. As laboratory experiments[5] had shown that ammonium sulfamate has a high toxicity for Bermuda grass, tests at roadside plots and at a tennis court were started with this salt as well as with calcium thiocyanate, as this compound had been used successfully in the eradication of nut grass.[6]

Series of experiments were started in October, January, February, July, August and September, so as to compare the influence of the various seasons. 0.5 to 3 liters of the solution were sprinkled per square meter, which contained from 200 to 1,000 plants. The calcium thiocyanate has always been used as a solution 1.25 molar in CNS^-, while the concentration of the ammonium sulfamate varied from 0.5 to 2 molar. We are obliged to the American Cyanamide Company for the supply with calcium thiocyanate solution and to E. I. du Pont de Nemours and Company, Inc., for the ammonium sulfamate.

The control of the Bermuda grass has been completed within a week with as small an amount as 0.6 l. 1.25 m CNS^- per square meter if there was no rain in the first four days after the treatment. The plots remained free of weeds for three to six months after the treatment. However, the success of the treatment depends largely on the season. In dry weather the control was complete. If there was about 0.5 inch rain in the first few days after the application of the solution, complete control of the weed could still be reached by the use of 1 liter 1.25 m CNS^- per square meter. Heavier rains limited the eradication and could not be counteracted by higher doses of the herbicide. Also the length of time for which a complete control lasted was influenced by the rain, immigration of weeds, especially crowfoot grass (*Eleusine indica*) from neighboring plots occurred much quicker in the rainy than in dry season.

Ammonium sulfamate killed the Bermuda grass in doses of 0.6–1 liter of molar solution completely in the dry season. The control lasted from 3 to 5 months. Weaker solutions were only partially effective. The rain affected its action more than that of the calcium thiocyanate; 0.5 inch rain in the first 4 days already reduced the control to about 90 per cent., stronger rains made it rather incomplete.

Some of the plots treated with calcium thiocyanate contained also a large number of crowfoot grass (*Eleusine indica*). Ada Georgia[7] reports that carbolic acid can be used for its eradication, but otherwise little seems to be known about its chemical control. Its eradication by 1.25 molar CNS^- seemed much more difficult than that of Bermuda grass. 1 to 1.5 liter per square meter gave only a 50 to 80 per cent. control. The picture changed, however, when the treatment was preceded by a cutting of the grass. Then, 1 liter of 1.25 m CNS^- eradicated 90 to 100 per cent. of the grass within the first week, also heavy rains (more than 3 inches in the first 4 days) did not seriously interfere with the herbicidic action of the calcium thiocyanate.

Hence, it can be said that 1.25 m CNS^- or m ammonium sulfanate control Bermuda grass effectively if applied at the ratio of 0.6 to 1 liter per square meter in the dry season. 1.25 m CNS^- at the ratio of 1 liter per square meter will eradicate crowfoot grass only if the grass was previously cut.

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