NUTRITION AND DIET IN ATHLETES

J. MUSCAT

M.D., B.Sc., F.F.I.M.S.

Abstract

The value of different articles of food as sources of energy to athletes is d'scussed, Carbohydrates are the chief and best sources to be preferred to fats and pro teins.

The diet of an athlete must be well-balanced to contain essential elements in sufficient proportional quant'ties to supply required calories.

Regular weighing of athletes is important to ascertain that the input is equal to the output.

Nutrition and dieting are one of the cardinal mianstones on which depends maximum performance. Proper nutrition of an athlete is as important as the intense train'ng he undergoes. A sound dietary regime is absolutely essential to guarantee maximum physical fitness and consequently performance.

Part I. Nutrition

Man must eat to live; food is essent'al for survival and maintenance of good health. After ingest'on, the food in the digestive system is broken down by various chemical processes into simple elements identical to those which constitute the human cell. Absorbed by the intestinal villi, the end-products of the prote'ns, carbohydrates and fats, reach the cell-protoplasm through the blood.

Some are "Anabolics": contributing towards the growth of the organism by supplying the elements (proteins) essential for the construction and build up of new tissues, and for maintenance of health by making good the daily wear and tear of the body. Others (the Fats and Carbohydrates) supply the energy absolutely ind'spensable for the daily and continuous activities of the organism. The vitamins, the mineral salts (such as sodium, potassium, ca'cium, phosphorus, iron, magnesium, sulphur,) and water help to regulate the metabolic processes w'thin the human organism. Some of the surplus proteins and carbohydrates are stored in the liver. The excess of the carbohydrates wh'ch is not burnt out, is converted into fatty cells and deposited as stores of adipose tissue under the skin and around the organs.

The cycle of nutrition ends by the elim'nation from the body of those ingested substances which the organism does not metabolise and of those which may turn out to be harmful to it.

The human body may very well be compared to a man-bu'lt eng'ne; but, unlike the latter, it is definitely much more expensive to run; it is in continuous activity; it requires fuel uninterruptedly — of course in varying amounts depending on various factors as we shall see later, — throughout its span of life: from the very first instant a baby is born up to the very last breath on the death-bed. The Basal

Metabolic Rate of the human body is high: an individual requires an output of energy also whilst resting, even whilst asleep, so as to keep his heart beating, the blood-circulation flowing, the lungs and thoracic muscles expanding and contracting, the stomach and intestines and kidneys functioning; to subsidise any movement, however small, of our body or part of it, as turning over in bed or moving a limb.

The Nutritive Value of foodstuffs differs greatly between themselves depending:—

a) on the chemical composition:
b) on the degree of digestibility and ease of absorption; and
c) on the number of calories it supplies to the organism.

A healthy body at rest has been estimated to require: One calorie an hour for every Kg. weight. Therefore, an individual weighing 70 kgms. in 24 hours should require $70 \times 24 = 1680$ calories as a minimum at rest. This calorie requirement will naturally increase in direct proportion to the individual's physical activity: the heavier the work, the harder and more prolonged the training and duration of the competitions, the more intense the muscular activity, the greater will be the amount of calories burnt by the the body. Thus for light work the body requires 2200/2600 cal. per day; for moderately hard work 3200/3800 cals. per day; for heavy work 4000/5000 cals. per day. Very rarely does an athlete need more than 5000 cals, per day; an amount higher than this may have deleterious effects especially during heavy competition. Strictly speaking these figures should be taken only as "mean values", because in the calculations of the total calorie requirement by an athlete one has to take into consideration the following factors, viz.

a) the age, sex, body-weight and body-build of the individual; — a female athlete requires 4/5 that of a male counterpart doing the same type of exercise; in the muscular subject it is 5 to 6% higher;
b) the external temperature;
c) the energy one loses in carrying out his normal routine work;
d) the type of sport being practised; in those doing aerobic sport the calorie requirement is most high, about 4.337 cals per day.

The physiology of muscular work is basically the chemistry and the physics of the transformation of chemically bound energy into mechanical energy. Food may be considered as a piece of mosaic, the different pieces consisting of carbohydrates, fats, proteins, vitamins and mineral salts, held together chemically. Their disintegration yields mechanical energy. Theoretically, the energy for muscular work can be supplied by all the three: proteins, carbohydrates and fats; but in practice this is far from the truth in the field of sport.

Proteins

These are stored in limited quantities in the liver. They are not a good source of fuel, for the body. 1 gram of protein yields the same amount of calories as 1 gram of carbohydrates, i.e. 4.1 cal.; It has been estimated, however, that an athlete doing moderately heavy work would require about $2\frac{1}{2}$ kgm of meat daily, where he not to make use of any carbodydrates or fats.

Proteins, should never be used as a source of energy for exercise. It is quite uneconomical and wasteful source. Proteins, however, are very important for the growth of the organism. They, therefore, should be given more liberally in the young. Normally the protein ration should be about 1.6 to 1.8/kg/day. In youths, especially up to 12 years of age it may be increased up to 3/kg/day.

The amount of proteins is to be increased also: a) in the pre-seasonal period — as at such time the volume of the muscular mass of the body is increased; and b) in pre-competition days in some sports-events. It is important that the ratio of animal protein to that of vegetable protein should be 3:1, so as to guarantee to the organism sufficient "essential amino-acids". Milk, eggs and cheese are preferable to meat owing to their high biological

value, ease of digestion and quick absorption.

Fats

These are very rich in calories; 1 gm yields 9 to 9.5 i.e. double the amount supplied either by the proteins or carbohydrates. Notwithstanding, their use as sources of energy. In planning an athletic diet only limited amounts, should be given, except in very special cases, not withstanding their use as sources of energy.

The metablic breakdown of fat requires greater quantity of 0_2, which may turn out to be a handicap in the performance of the athlete — as in a long-distance runner, a cyclist, an oarsman, — owing to the concomitant increase in pulmonary ventilation. Also, owing to the greater usage of 0_2, there will necessary develop a greater amount of heat in the body, which will be a source of considerable distress to athletes competing in a hot and humid country. Maximum physical efficiency demands a minimum production of heat. And, in fact, it has been observed that: "when a diet is rich in fats, the duration of the maintenance of a strenous exercise is diminished and that exhaustion is more marked at its conclusion."

Fats are important as reserve stores of energy. The store of fats as adipose tissue under the skin and around the different organs lasts much longer than the glycogen store in the liver which is exhausted in a relatively shorter time.

As already mentioned, the inclusion of fats in an athletic diet should be more liberal: a) in northern countries owing to the cold climate, and b) in certain disciplines of sport in which body-weight is not a disadvantage, such as water-polo, weight-lifting, field-events.

The vegetable fats should be almost in the same ratio as the amount of animal fats, since the former provide the essential fatty acids which the body itself is unable to synthetise.

Carbohydrates

These are the chief and by far the best suppliers of energy to the athlete's organism, notwithstanding that 1 gm. of carbohydrate yields 4.1 cals, i.e. as much as 1 gm of protein.

In the form of glycogen, carbohydrates are stored:

a) in the muscles themselves, though not in large amounts; and
b) in the liver, normally from 50 to 100 grams.

During exercise the muscles make use of glycogen. For efficient muscular activity a sports competitor requires adequate amounts in easily digestible form and in the right proportion to other dietary elements. A high carbohydrate intake 24 to 48 hrs. before competition, especially in an endurance event, is very desirable to boost the liver-glycogen stores; but, the ingestion of pure glucose immediately before an event is of no positive value to the competitor; on the contrary, it may be harmful.

Christen and Hansen who carried out a number of experiments in this field arrived at the following conclusions:—

1) Athletes are able to perform much better — about 3 times as much — if kept on a high carbohydrate than on a high fatty diet;
2) The utilisation of carbohydrate depends on the 0_2 supply of the the working muscles: the more inadequate the 0_2 supply, the higher will be the carbohydrate utilisation.
3) the initial glycogen content in the skeletal muscles is of very decisive importance for the athlete's ability to sustain prolonged heavy exercise; the higher the initial glycogen content, the better will, be the performance."

Bergstrom and his collaborators in a study on "Diet and muscle glycogen and physical performance" have observed that "if the glycogen-depots of an athlete are first emptied by heavy prolonged exercise, then maintained for 3 to 4 days on a diet low in carbohydrates, and finally given for a few days a diet very rich in carbohydrates, the glycogen content became raised to over 4gm/100g wet muscle, and that such an athlete could than per-

form the heavy work for much longer periods, even up to 4 hrs. The total muscle glycogen content under such circumstances could exceed 700gm.

Before events, the carbohydrate should preferably be administered as a mixture of: maltose, fructose, and lactose, owing to their quicker metabolism and easier absorption. Moreover, fructose does not excite insulin liberation, and, therefore, the danger of hypoglycaemia is eliminated."

Water

Like food, water is absolutely indispensable for life, the more so to athletes. It is better to drink too much than too little; the excess will be eliminated by healthy functioning kidneys and through sweat. On an average man drinks about 1 litre in 24 hrs., besides the taking of another litre with food in the form of soup, milk, coffee, tea, and wine. Ofcourse it goes without saying that in hot climates and during hard training and strenuous competition much more water than normal is required by the body so as to make good that lost through perspiration. Owing to muscular exertion the body-temperature rises; the body counteracts this by sweating. It has been calculated that in a hot humid weather a lightly-clad athlete may sweat as much as 9 gm in 1 hr. (about 2 to 3 litres, and sometimes even more).

The quantity of water required by an athlete depends on various factors:-

a) the size and body-surface of the athlete himself;
b) the external temperature; whether he is competing in a hot or cold country;
c) the humidity of the place: to which it is in inverse proportion; and
d) the duration and severity of the competition.

Normally the quantity of fluid required should be in the region of 40 to 50 cc per kg. of body-weight per day.

1 gm of water lost through perspiration wastes 0.58 cals. A normal individual loses about 850cc water through perspiration, wasting 490 cals. The lost water must be replaced preferably at the same rate at which it is lost. In hot countries and when training is heavy, ample fluid should be taken on the day preceeding the event. Only limited quantities of water may be taken some hours prior to the actual competition.

Mineral salts

Calcium, magnesium, phosphorus, iron, sulphur, sodium and potassium, do not furnish any energy; but they play an important role and greatly contribute towards the well-functioning of the human-machine. Calcium, phosphorus and magnesium are essential for bone formation. Calcium is one of the factors necessary for the coagulation of the blood; and, together with Magnesium, it is responsible for for the normal function of both the cardiac and skeletal muscles and of the nervous system. Deficiency of calcium is responsible for abdominal and muscle cramps, tetany, and osteomalacia.

Iron is indispensable for the formation of Haemoglobin which is responsible for the taking up of 0_2 from the lungs and its subsequent distribution to the tissues.

Potasium, sodium and chloride have received due attention. Their importance in athletes can be proved by the number of studies being done in this field. It has been demonstrated that a deficiency of sodium, chloride and particularly potassium plays an important role in the production of heat injury. When an athlete sweats profusely, he may lose as much as 3 gm or more of salt in 1 hr. With the sweat there is also loss of potassium. Without suitable replacement, there is great risk of hypertonic dehydration leading to weakness, fatigue, muscle cramps, and eventually to heat exhaustion and stroke.

It has been shown experimentally that in potassium depletion, the utilisation of carbohydrate is depressed, and consequently, there results a shift from the efficient aerobic glycolysis to the much less efficient anaerobic glycolysis; and there will also be a disturbance of the production of adenosine triphosphate and oxidative phospherylation.

According to Fordtran and Salten the gastric emptying and intestinal absorption

of saline solutions would be rapid enough to replace all of the losses of sweat incurred during heavy exercise, even in hot climates. However, if glucose is added to the water, there will be a rather marked inhibition of gastric emptying. Therefore, high concentration of sugar in an orally ingested water solution may cause large amounts of fluid to be retained in the stomach, and this will procure abdominal discomfort during the competition, which will be a great handicap." To counteract this some sports medical officers administer glucose saline solutions intravenously on the eve of competitions.

Vitamins

One cannot stress the importance of vitamins to athletes; but may it be said outright that there is much abuse in this field. It is universally and scientifically established that a well-balanced diet, i.e. a diet containing eggs, milk, cheese, meat, plenty of fresh vegetables and fresh fruit (especially lemons, oranges, tomatoes, bananas) should provide the body with the sufficient amount of vitamins required by a top-performing athlete. Excess of vitamins will definitely not improve the athlete's performance; on the contrary, some assert that excecss of vitamins may be harmful to the organism as it may upset its vitamin-balance. Undoubtedly vitamins must be prescribed only when for some reason or other they are absent or present in insufficient amounts in the nutrients eaten.

Part II: The diet of an athlete

In planing an athletic diet it is important to include all the essential elements of food in "sufficient proportional quantities", so as to supply a balanced diet providing at the same time the required number of calories. On an average daily requirement the diet should consist of:-

600 gm Carbohydrates,

150 gm Proteins, of which 70 gm should be of animal origin.

150 gms. Fats, of which almost half should be vegetable.

Included in the menu' should be: meat, eggs, milk, cheese, green vegetables and plenty of fresh fruit, and a certain amount of salt.

Speaking in terms of calories, in a well-balanced diet: the carbohydrates should yield 60 to 70%, the proteins 12 to 15% the fats 20 to 25% of the total calorie value.

Strictly speaking, there is no hard and fast rule re the exact number of calories to be supplied to each individual from time to time since the following factors must always be taken into coensideration:-

1) the age, sex, body-weight and body-surface of the athlete;
2) the type of sport, the muscular work involved, and the duration of the competition, and also the duration of the training sessions. Naturally swimmers, cyclists, and marathonists where the muscular exertion is quite strenuous and prolonged may need more calories than a sprinter, a high or long-jumper, a jockey or a golfer.
3) The temperature and the degree of humidity of a place has a big bearing on the total calorie requirment and also on the type of food to be supplied to competing athletes.

A diet is appropriate only if it provides the athlete with enough calories to maintain his average weight at a constant level both during sessions and during competitive periods. The entry must equal the output. So, the best way to judge whether enough calories are being supplied in diet is by weighing athletes at regular intervals to notice any loss or gain in weight.

Apart from the biological and energetic properties, the food:-

a) should be as plain as possible; condiments should not be added.
b) must be well prepared and properly cooked;
c) must be easily digestible;
d) must be varied;
e) must conform as much as possible with the tastes of the individual;
f) should not comprise gas-producing articles as peas, beans, cauliflower, and cabbages, as these are liable

to cause colicky pains, thus hampering the athlete's performance.

During a meal one is not to drink any water possibly; if thirsty, one can have some water at the end of the meal. Beer and aerated drinks should be avoided; but a little wine is permissible.

The total daily requirement of calories should be divided into 3 meals, the amount and time of each meal depending on the time and duration of training or of the competition. A meal must be taken fully 3hrs. before the onset of a competition; in the case of swimming events at least 4 hrs. should elapse. For the same physiological reasons at least 2 hrs. should pass from the end of the competition before an athlete is allowed to consume a regular meal. Immediately after the event he may safely take water, oranges, fruit-juices, coffee or tea with little milk and some sugar. The last meal should be timed at least 2 hours before going to bed. It is of the utmost importance that an athlete observes a set diet also during "his holiday, when out of training. During these few weeks he should reduce his carbohydrate intake as his activity is reduced. If he puts on extra weight, he will be at a disadvantage when he will resume training regularly later on.

One should remember, however, that whatever are the physiological principles regulating an optimal diet, the practical considerations demand that the diet has to be acceptable to the individual. If an athlete believes in a food fad or in a miracle pill, this fad or pill may cause him to win, provided, of course, that his diet is otherwise fully adequate and balanced. Education in this field of diet is still backward. Many have yet to learn that proper menus play an important part in the planning of programmes for sporting events. It is to be regretted that quite a number of officials, coaches and athletes themselves have mistaken ideas about the appropriateness and value of the food to be consumed during training and competitions. Many attach an exaggerated importance to big fillets of meat and to meat in general; some refuse to include rice, potatoes, paste or bread; whilst others, Italianwise, consume daily big quantities of spaghetti and will not renounce to the glass of wine. There are others who insist on having too many eggs and ham or bacon, or an overabundance of sweets and fruits. It is likewise a misconception to adopt a dietary regime after a particular champion or record-holder. Many sportsmen have had their careers ruined by injudicious dieting.

References

BERGSTRON, J.C. and HERMANSEN, F. (1967) "Diet muscle glycogen and physical performance. Acta Physiol. Scand. 34,38.

CHRISTANSEN, B. & HANSENK (1939).

FINO FINI "Sport e Medicina" Press Sport Firenze (1966).

FORDTRAN, JS. and SALTIN B., "Gastric emptying and intestinal absorption during prolonged severe exercise", J. Appl. Physiol. 43,96.

LACAVA, G. (1973). "L'Alimentazione dell'atleta; "Manuale Prattico di Medicina Sportiva55 (Ediz. Minerva Medica.

PLACIDO, V.J. (1974). "The importance of fluid and electroyltes in Athletes" Journal of Sport Medicine and Physical Fitness 14,58.

VENERANDO, P. (1974). "Testo Medicina dello Sports" (Edi. Societa' Editrice Universo 1974).