

Pigeon Racing: Breast Muscles and the Fuels for Flight

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As mentioned in an earlier article on this subject, in pigeons, there are some 50 different muscles and muscle slips that have an action on the bones and feathers of the wing. Of these 50, there are two major flight muscles that are of interest to us. The first and more massive of these are the large muscles found on each side of the keel, those we feel with our fingertips as we handle the bird. These great muscles make up from 20-32% of the total weight of the bird.

If we kill a bird, place it on its back, and strip the skin off the underlying tissues, we can see these great muscles lying on and attached to either side of the keel. As we look closely, we see that the "grain" of the muscle runs from the keel in an upward and outward direction at an angle of about 45 degrees, forming a 'V' with the keel. These muscles are known as the major pectorals, which are highly developed in flying birds.

As you might expect, the major pectorals are the most powerful flight muscles in pigeons, as they are in other flying birds; their main function is to pull the wing through the powerful down stroke, which propels the bird forward and provides lift. The other important flight muscles of pigeons are the much smaller and more deeply located deep pectorals, sometimes called the minor pectorals or the supracoracoideus. These small muscles have the important function of raising and rotating the wing during flight, but make up only about 4-5% of the weight of the bird. Between the actions of these two muscles, the wings are raised and lowered on the average of 5.4 times a second at cruising speed for the duration of the flight. By contrast, during the short, explosive launch phase, the wings beat on average at the rate of 9.5 times per second.

.The large breast muscles that we feel as we handle a bird contain two kinds of muscle - red and white. Red muscle makes up about 85-95% of these breast muscles, whereas white muscle makes up only about 5-15% of the total. Both red and white muscle operate (twitch) extremely rapidly, but white muscle twitches much faster than red muscle. To give you an idea of how rapidly red muscle is capable of twitching, note that the breast muscles of the hummingbird are comprised entirely of red muscle, and in flight, the wings of this bird are a mere blur. However, as fast as it is, red muscle twitches relatively slowly compared with white muscle, and as a result, it also tires out very slowly. Because of this fact, it is obvious that red muscle is used for the prolonged effort of sustained flight, from training tosses to long distance, and even endurance events.

On the other hand, white muscle twitches very rapidly, and so tires out very quickly. Because it tires out so quickly, white muscle can in no way handle prolonged flight, but is used for lightning fast movements, such as launching the bird into the air, and rapid dodging bursts of speed during flight, etc..

Now, what are the major fuels needed to carry a bird from a short training toss to a major distance event, say a 500-mile race or more? Some fanciers believe that glucose is the fuel needed by muscles for training tosses and short races, and that fat is needed only as the distance increases. However, extensive research in Canada by Dr John George and his graduate students at the University of Guelph in Ontario, has shown that fat is the major fuel used by red muscle for training tosses and for many hours on the wing -- races of any distance, from short to long.

By contrast, glycogen is the major fuel of white muscle, and is utilized very rapidly. For example, Dr George and his group have shown that the glycogen in white muscle is completely used within the first 10 minutes after launch at the liberation point, and to all intents and purposes, white muscle stops working until it is recharged with glycogen during the race, from sources in the liver.

At this point, we need to digress momentarily for a brief discussion of glucose, glycogen, starch, fat and protein in the context of fuel for flight. Glucose, sometimes also called dextrose, is the main sugar used by animals and birds for the production of energy. If there is excess glucose beyond the immediate needs of the body, the excess can be stored. The storage form of glucose is called glycogen. In this process, cells in the liver are able to link many units of glucose together in a particular chemical configuration that we recognize as glycogen, and just as importantly, it is able to store this glycogen in liver and muscle. When glucose is required, glycogen is broken down rapidly for immediate use.

Now, if we crack open a grain of maize or wheat, we are immediately aware of the white, starch-like interior -- and, in fact, this substance is starch. Like glycogen, starch is composed of many units of glucose linked together by plants in another particular chemical configuration that is different from that of glycogen. What becomes apparent immediately is that starch is the storage form of glucose in plants and their seeds, and that glycogen is the storage form of glucose in birds and animals.

After grains are ground in the gizzard of pigeons, the resulting mash passes into the first part of the intestine, where digestive juices break the starch into free units of glucose. The free glucose is then absorbed through the wall of the intestines, and from there, into blood vessels that transport it to the liver. Here, some of the glucose is converted to glycogen and stored, and some is exported in the bloodstream to the flight muscles where it is converted to glycogen and stored until it is required as a source of energy. Very importantly, some of this glucose is also converted by the liver into fat, the chief fuel for sustained flight.

Fats, which are also known as triglycerides, are the major fuel needed by racing pigeons during the racing season, and indeed, by any species of wild bird that flies extended distances, as in Spring and Autumn migrations. It has been noted that the capability of birds for storing triglycerides as an energy reserve, exceeds that of other classes of vertebrates (animals with vertebral columns). Note this important point: the amount of energy provided by the utilization of fats is over twice as much as that produced by the utilization of carbohydrates and protein combined. The importance of fat as the major fuel for racing, or for any prolonged flight, such as that of migrating birds, cannot be over-estimated.

Fats from the diet are mixed with bile in the intestines. This process splits the fat into glycerol and free fatty acids, which are then absorbed into the bloodstream and are carried to the liver. Here the fatty acids are reconstituted into fats (triglycerides) and stored. Some of the fatty acids are transported to fat depots in various parts of the body, and importantly, to red muscle where they are stored in a microscopic form as a source of fuel for cruising flight. For our purposes, even though it is not strictly correct, we will use the word fat when we mean fatty acids. The facts about fat as

the key fuel for racing were established many years ago by Dr George and his group who published many scientific papers on all of this work.

Perusal of other available scientific literature on the metabolism of protein, carbohydrate and fat in birds in general revealed some interesting information that could be very useful in preparing pigeons for racing. Here are some of the facts taken from pertinent scientific literature on birds:

The liver is the major organ in which the vast amount of fat is produced. In fact, in birds, almost 50% of the fat produced for use in the body is produced in the liver and is exported to storage sites and muscle through the blood stream from there. It is interesting to note as well that bone marrow is another important site for fat production in birds, and that bone marrow itself has about two thirds of the fat producing activity of liver.

After it is produced in the liver, fat is transported in the blood stream in the form of fatty acids to the body depots for storage, and very importantly, to working muscles where it serves as a ready fuel supply for sustained flight.

Fine so far, but there are a couple of interesting points to consider.... Logic would say that the addition of extra fat to the diet of racing pigeons would help the liver with production, and would just add to the amount of fat produced normally by the liver, and subsequently exported to storage sites. In fact, one study several years ago showed that the addition of 5% fat to the diet of racing pigeons, improved performances, especially from distances beyond 200 miles, whereas birds that were not supplemented with fat had poorer performances overall. This study also showed that, once clocking from beyond 200 miles started, more birds fed the diet containing the additional 5% fat were clocked in a given period of time, than birds not fed the extra fat. These findings indicated the very marked increase in stamina or endurance provided by the additional fat in the diet.

The addition of extra fat to the diet should assist the body in building fat reserves. Firstly however, there are a few other points to consider. In birds in general, it seems that the following points are important:

1. High levels of fat in the diet of birds will DECREASE the amount of fat produced by the liver.
2. High levels of protein in the diet of birds will DECREASE the amount of fat produced by the liver.
3. High levels of carbohydrate in the diet of birds will INCREASE the amount of fat produced by the liver.

On the matter of high levels of fat in the diet, in one study in chickens, it was found that the addition of 10% fat to the diet of young chicks actually decreased fat production in the liver by a startling 40%! However, it is important to note that when amounts of carbohydrate in the diet are held at a constant high level, high levels of dietary fat don't seem to interfere with fat production by the liver!

In migratory birds, it is known that abdominal or "migratory" fat is distinguished from fat that collects beneath the skin ("winter" fat). Winter fat is used mainly for insulation against the cold. Migratory fat accumulates rapidly in large amounts just prior to migration, and is exhausted at the end of migration. These findings suggest that it is likely that the fat we build each week as fuel for racing in pigeons is of the "migratory" type, because of its rapid accumulation in the body cavity in the few days before shipping, and its subsequent utilization during the race.

Of significance to fanciers was an important study by US scientists in 1967. The results revealed that intravenously injected glucose tagged with a radio-active label (attaching a radio-active label to the glucose allowed these scientists to follow the glucose and determine its fate in the body), was incorporated into fatty acids in the liver within three minutes in hungry young pigeons, and that the content of fatty acids in liver reached a plateau in 15 minutes. Significant appearance of fatty acids in blood and fat depots was seen first at 15 minutes after the injection, and their concentration rose continuously throughout the two-hour experimental period.

Obviously, the pigeons in this study were utilizing glucose very rapidly in the production of fat -key information for our purposes. This study also confirmed the fact that the regulation of fat production in the pigeon occurs in the liver.

Incidentally, in less than two hours after feeding glucose, either as the sugar given in water, or after the conversion of starch from grains into glucose in the intestines, there is also rapid production of glycogen by the liver of birds. Some glycogen is stored by the liver and some is exported in the blood to muscles and other tissues as a source of energy. For example, glucose is the major source of fuel for the brain. So the feeding of carbohydrate-rich grains -wheat, oats, barley, maize -- is an important step in supplying glucose, which in turn is readily converted in the liver to glycogen and the important fatty acids, the key fuel for prolonged flight. Obviously, the use of glucose in the drinking water prior to shipping adds very much to this entire process.

Another important point to re-iterate in this discussion is that fat production by the liver of birds is greatly increased when levels of carbohydrate in the ration are high. So, if you feed high-fat grains in any amount -- grains such as peanuts or sunflower seeds, etc. -- especially toward shipping day, be sure that you also feed lots of cereal grains, e.g., maize, wheat, rice, etc..

Now what is the role of protein in the racing bird? This is an important point because a number of fanciers continue to feed high levels of peas and beans as fuel for racing. Protein is highly important in the maintenance and repair of damaged muscle and other tissues. It is not an energy food and would not be used as such by the bird for flight except when all reserves of fat and carbohydrate are completely depleted. The bird that returns home days or weeks late with wasted breast muscles has likely had to resort to using the protein of muscle as a source of energy -- hence the wasting. So much of the muscle has been used as a desperately needed source of energy that it may never return to normal.

On the subject of using protein for the maintenance and repair of muscle, an interesting study done by Dr George in migrating Canada Geese showed that at the end of Spring migration, there was considerable damage and degeneration of the major breast muscles, likely as the result of the stresses of wear and tear that can occur during prolonged flight. These findings in migrating geese might just be applicable to racing pigeons after they have flown a race of any distance, but might be most important when races are tough. Perhaps any tough short or long race might result in similar degenerative changes in our racing birds. Thus, it would seem logical to me that the sooner these potentially damaged muscles are repaired and restored to normal, the sooner is the bird likely to return to good racing condition.

If high-protein grains are to be fed during the racing season for the repair and maintenance of muscles and other tissues for example, it seems logical then that they should be fed earlier rather than later in the week -- to allow for rapid repairs to possibly damaged muscle. Logically, repairs should come first, followed a bit later by a build-up of fuel for racing. This doesn't mean that fanciers can't use the traditional light to heavy feeding schedule to prepare birds for the next race, but it seems reasonable that any repair of damaged muscle should occur before that muscle is refueled.

Recall also that feeding high levels of protein will decrease the amount of fat the liver is capable of producing -- another good reason not to feed high levels of protein at the end of the week toward shipping day. Because a number of the high fat grains such as peanuts, sunflower seeds, etc., fed toward shipping day, are also high in protein, I would suggest that they be fed in moderation, not as a cropful.

At the same time, we should be certain that the amount of carbohydrate in the diet is at a high level, i.e., by the use of a high proportion of cereal grains, especially grains like maize, wheat, oats and rice, for example. Glucose or honey could be added to the drinking water to help supply the extra carbohydrate needed in the production of fat. (Note: Don't put glucose or other sugars in the water day after day. Use these sugars for only a day or two at a time, to prevent the growth of yeasts and mould in the crops of your birds, since these yeasts, etc. use the sugar as nutrients for their own growth, and can invade the wall of the crop at this time.) These measures would take advantage of the fact that when the level of carbohydrate in the ration is at a reasonably high level, increased dietary fat does not seem to interfere with fat production by the liver of birds.

One other intriguing but practical method to improve fat production in racing pigeons could be the use of the sugar fructose. Fructose is available as a powder and can be found in health food stores as well as grocery stores. Compared with table sugar, fructose may be expensive. Another practical source of fructose is honey which contains about 40% fructose and 30% glucose.

Why use fructose, when glucose seems to be the major sugar in the body of birds, the liver of which has a significant ability to convert glucose to fatty acids in a very short period of time? First, some background. Most grains, especially the cereal grains, contain a high percentage of starch that, as we have seen, is a complex chemical structure composed of many individual units of the sugar, glucose. When the starch in grains is digested by pigeons, it is fractionated by digestive juices in the intestines into glucose, which is then absorbed through the intestinal wall into the blood stream and transported to the liver.

It is known that in birds, the absorption of glucose from the intestine into the bloodstream far outstrips the absorption of fructose. However, if fructose is present, it too will be absorbed from the intestine of birds and transported to the liver where it is metabolized (utilized) rapidly. It is significant that the liver of birds is able to metabolize fructose very rapidly and efficiently, even if there are also high levels of glucose present as well. The rapid and efficient metabolism of fructose by birds is not hindered by simultaneously high levels of glucose as it seems to be in mammals.

Another key fact about fructose is that in birds, fat production from the metabolism of fructose exceeds that of all other carbohydrates collectively! Another highly significant point for us as pigeon flyers is that in birds, the metabolism of fructose and its conversion to fat receive very high metabolic priority - a key fact! This information offers another practical clue to the process of fuelling pigeons for racing- i.e., use fructose to build necessary fat reserves, especially for the tougher distance events!

It seems to me that the use of fructose could be a major factor in rapidly rebuilding fat reserves in a pigeon as it races, say in a widowhood situation, for several weeks in a row. Maybe the problem of "picky appetite" and the concurrent need to rebuild fat reserves in widowers might be solved very nicely through the use of fructose or honey in drinking water. A racing widow/widower may have a capricious appetite at times, but the more dependable need for a drink of water, to which fructose can be added for a day or two, for example, might provide a partial answer for those birds with the touchy appetites.

Fructose could also be valuable in rapidly rebuilding fat reserves in exhausted birds when they return from a grueling race, looking like shadows of the birds entered originally in the race. It seems to me that, in looking at these facts, it becomes evident that feeding high levels of carbohydrates in general, and that feeding simple sugars such as glucose and fructose specifically, could be highly valuable in rapidly building fat reserves in racing birds, virtually when we want them!!

Now, some general points about nutrition, plus some odds and ends:

We are told that breeding pigeons can do well on a diet containing 13-15% protein. One group of investigators found that when pigeons were offered cereals and peas free choice, the mixture chosen by the birds corresponded to a protein intake of 12.5-13%. However, these investigators also found that a ration containing 18% protein, obtained by adding soybeans or fish meal to the diet -- which add high quality protein -- resulted in optimum hatchability, growth and development of youngsters. They also found that levels of protein higher than 18% did not result in further improvement in growth and weight gains of youngsters. These findings indicated that a ration containing upwards of 18% protein, but not higher, should be ideal for breeding and rearing.

To achieve a ration of 18% protein means adding higher amounts of peas or beans to the diet. In my own situation, I use a ration of 25% peas (a mixture of green, white and maple peas, but only 5-10% maple peas because of their content of high levels of substances that interfere with the metabolism of protein). As well, I add 10-15% of a 28% protein pellet obtained locally, plus wheat, maize and safflower, all of which results in a ration of 17-18% protein. I find this ration to be ideal for breeding and rearing.

To be certain that the systems of both cocks and hens are nutritionally prepared for the breeding season, a change from the bland winter diet to a ration higher in protein needs to take place well in advance of the breeding season. Sheep breeders use a similar approach and apply the term "flushing" to indicate feeding a higher level of quality feed prior to the breeding season. According to one university poultry nutritionist I contacted, this dietary change in pigeons should be made about four weeks prior to pairing the birds.

Too often, I find that some fanciers don't change from a bland, maintenance diet used over the winter, to one of much higher protein until just before pairing, or worse, until after the eggs are laid. The result can often be infertile eggs and embryos that die early in incubation or right at hatching. This situation can be vastly improved by providing a higher protein ration well in advance of pairing, along with a free-choice loose mineral mix, granite grit and oyster shell or calcium carbonate rock chips. During the driving period, I like to provide the mineral, grit and oyster shell in cups right in the nest box, to ensure that the hen in particular has ready access to these important nutrients.

Fanciers should be aware that nutritional deficiencies are not the only cause of weak and dead-in-shell youngsters. Infection of the ovary by paratyphoid or E. coli bacteria, etc., which are then incorporated in the egg before it is laid, can produce the same result, so it behooves a fancier with this type of problem to consult his veterinarian about submitting dead-in-shell youngsters for bacterial examination.

Iodine should be present in a mineral mix for pigeons because of the apparently high demand for this mineral in milk-producing species of birds. Some fanciers use kelp powder or flakes to supply the needed iodine. Don't add more than a drop or two of extra iodine to the drinking water! Too much is definitely toxic!

Crop milk, produced by the sloughing of fat-laden cells from the lining of the crop, is produced in both sexes under the influence of the hormone prolactin which is released from the pituitary gland at the base of the brain. This release of prolactin is probably triggered by driving and breeding activity prior to egg-laying, since it is likely the hormone responsible for inducing "broodiness" in both males and females.

Although a recent article stated that crop milk begins building only toward hatching, the fact is that the presence of crop milk is seen first on the wall of the crop at about 8-10 days of incubation, and increases in amount toward hatching. As well, the crop becomes increasingly rough and somewhat folded as milk production increases. Newly hatched youngsters are fed regurgitated milk continually up to about 9-10 days of age, when more grains are added to the diet, and the supply of crop milk decreases.

When crop milk is analyzed it is found to contain about 75% water, 12% protein, 5-7% fat, and 1.2-1.8% mineral. There is almost no carbohydrate in crop milk. Calcium, phosphorus, sodium and potassium are present. Unlike mammalian milk, crop milk has no lactose or casein. It is low in vitamin A, vitamin B, (thiamine) and vitamin C (ascorbic acid), but has about the same amount of vitamin B2 (riboflavin) as milk from cows. When fed to chickens, crop milk stimulates growth.

Like many other birds, other than some species of aviary finches, pigeons are believed to produce vitamin C (also called ascorbic acid) in their kidneys, so in general, extra supplies of this vitamin are likely not needed. One exception might be during the racing season when it becomes very hot on some race courses. It seems that as an "anti-stress" substance, vitamin C may exert its most important effects during very hot weather, and supplementation before these races may be valuable for that reason.

Experimental work with vitamin C in chickens suggested that the anti-stress effects of the vitamin occur in the adrenal glands. In chickens, the optimum dose of vitamin C as an anti-stress agent was 100 mg/kg of feed. In these experiments, vitamin C appeared to be valuable in preventing the stress response, respiratory infections, and E. coli infections, results that could also have similar practical application in breeding and racing lofts.

In the wild, pigeons like a variety of grains. Of course, many of their choices will depend on the availability of various grains, seeds, etc. at any particular time of the year. In some studies conducted in New Zealand, the crops of free-ranging pigeons were found to contain slugs and worms, etc., findings that may indicate a need for dietary proteins of animal origin. It is also puzzling that some species of pigeons and doves seem to do well almost exclusively on a single type of food. A good pelleted feed containing animal tissues for use in the livestock industry could be helpful here.

In a study on food deprivation, it was shown that pigeons lost 5% of their body weight after three days without food. To regain this lost weight required five days on food. It took eight days without food to achieve a 15% loss of body weight, and 10 days to regain the lost weight. It required 19 days without food to achieve a 25% loss of body weight, and 15 days to regain this loss.

Plant pollen collected by bees is often touted as a magic ingredient for racing pigeons. It is the male germ seed produced by all flowering plants. However, its nutritional value is somewhat compromised by the high content of fiber. As a result, it has lower than desirable digestibility in humans and other simple-stomached animals.

Pollen contains about 24% moisture, up to 30% protein (average - 24%, including up to 17 amino acids), very little starch (average - 2%), 20 - 30% sugars (some samples have averaged 19% fructose, 10% glucose), about 5% fat, 3% ash (including high amounts of calcium, magnesium, and zinc, plus lesser amounts of potassium, sodium, sulphur, and manganese). Pollen is high in B vitamins (except 131j, and has a fair amount of vitamin C, but lacks vitamins D and K. It has a pH about 4, i.e., on the acid side of neutral.

Brewer's yeast is another favorite of fanciers. Its name is derived from the beer brewing process of which it is a by-product. Yeast produced by the brewing industry tends to be bitter and difficult to consume in significant amounts. Today however, most yeast marketed does not come from breweries, but are grown for the sole purpose of food supplements. These yeasts may be marketed as "nutritional" or "primary" yeasts. Unlike baking yeast, nutritional yeast is considered to be a "dead" product, and will not work in the leavening process.

The vitamin and protein content of nutritional yeast depends on the medium in which it is grown. Food yeasts are a rich source of nutrients, and may contain as much as 50% protein. They are an excellent source of B vitamins except for B121 which is now added to some brands for human use. Yeasts are a good source of minerals, especially selenium, chromium, iron and potassium. Phosphorus is also abundant in yeast; to maintain a favorable balance between calcium and phosphorus, some producers add calcium to their product. Yeast is a good source of nucleic acids, including RNA. It is low in fat, carbohydrates, sodium and calories.

Many fanciers like: to use garlic during the racing season. The principal, active agent of garlic is allicin, a sulphur-containing compound, which, with its breakdown products, produces the characteristic odor. The odor is related to the presence of sulphur. When the cloves are crushed, allicin is formed by the action of enzymes on a pre-existing chemical known as afflin. Other biologically active compounds related to allicin, such as ajoene, may be extracted from garlic as well.

The positive effects of fresh cloves of garlic seem fairly certain, whereas information for modern commercial preparations in general is not very convincing, to say the least. One reason for the difficulty of showing the effectiveness of garlic is that many active chemical compounds in the cloves may be lost during processing -and this is a major problem with commercial products. Allicin is known to break down during steam distillation for the production of the volatile oils used in many garlic preparations. As well, the allicin content of natural garlic can vary 10-fold.

There is also confusion about the issue of "odorless" garlic preparations. Some of them have no aroma, but neither do they contain any active ingredient. Some active preparations may not have an odor, but if allicin is released when the

product is eaten, there is a very good chance that there will be a detectable aroma -and it is the aroma that is one of the problems. Potency of garlic appears to depend on pungency, - that is, odor. Once garlic is dried into odor-free powders or pills, it loses some of the properties that may make it useful in health!

Given the "touchy" nature of the important, active compounds in garlic, it seems that heating or boiling crushed cloves above 60°C (140°F) (remember that water boils at 100°C (212°F)), likely results in a major loss of key ingredients. On the basis of this information, it is logical that home preparations of solutions of garlic should not be heated, in order to retain the important compounds in the solution. Be aware that allicin is readily converted to a more volatile compound called diallyl disulfide -- which means that its effects can be transient.

Allicin is known to have antibacterial properties and has been said to be effective in concentrations as low as 1:125,000. When compared with penicillin, allicin is said to have an activity that is about 1% of the activity of penicillin. Garlic inhibits the growth of, or kills, about two dozen kinds of bacteria (including *Staphylococcus* and *Salmonella* spp.), and at least 60 types of fungi and yeasts. Allicin appears to be the major chemical responsible for this effect.

The trace minerals selenium and germanium are two constituents of Japanese garlic, and these minerals may have some effect by their activity firstly, as antioxidants, that is, substances that protect cells and tissues from the damaging effects of peroxides in the body. Secondly they are important in the normal development of the immune system, and thirdly, they may have good activity as anticancer agents. Selenium itself has been shown to have a broad spectrum of anticancer activity in rats, for example.

There are indications that chemical compounds in garlic may assist the body to de-toxify, neutralize or eliminate noxious substances. In pigeons, the use of garlic after a race may assist the so-called "depurative" diets -- whatever that might mean -in restoring a bird to normal racing condition. It is possible that the use of crushed garlic cloves in drinking water at this time might add some extra benefit in allowing the liver and other organs to metabolize products, and to help restore the birds to normal racing condition.

To summarize -- present evidence from human and laboratory animal work, and the empirical experience of many fanciers, suggest that, when used appropriately, crushed cloves of garlic, used in drinking water, may be a useful product in the loft throughout the year, but especially during rearing and the racing season. At present, garlic-based oils, powders and pills are likely much less useful. Possibly newer developments in extracting the active principles of garlic may get around the present problems associated with current methods. Until these problems are solved, fresh cloves of garlic from the grocery store are still the best source of the medicinal properties of garlic. Another reminder - don't heat garlic solutions for fear of inactivating the important ingredients. Leave prepared solutions on the counter or refrigerate them - but don't heat them.

One prominent fancier I know crushes or grinds five or six individual cloves of garlic and adds them to one quart of water which is then refrigerated over night, and added in small amounts to individual drinkers, usually on Tuesday and Wednesday each week during the racing season. In the next day or two, he finds down feathers in abundance in the loft, the skin over the breast muscles becomes clearer and the muscles themselves are a distinct healthy pink.

Honey is a natural food that contains about 17% water, and 82.4% carbohydrates. It is interesting that honey contains about 38.55% fructose (range 25-44%), 31% glucose (range 25-37%), 7% maltose and 1.5% sucrose, as well as small amounts of several B vitamins and a range of minerals. It can be a helpful pick-me up for recently returned racers and can be useful as sources of glucose and fructose, those key sugars used in building fat reserves for upcoming races.

