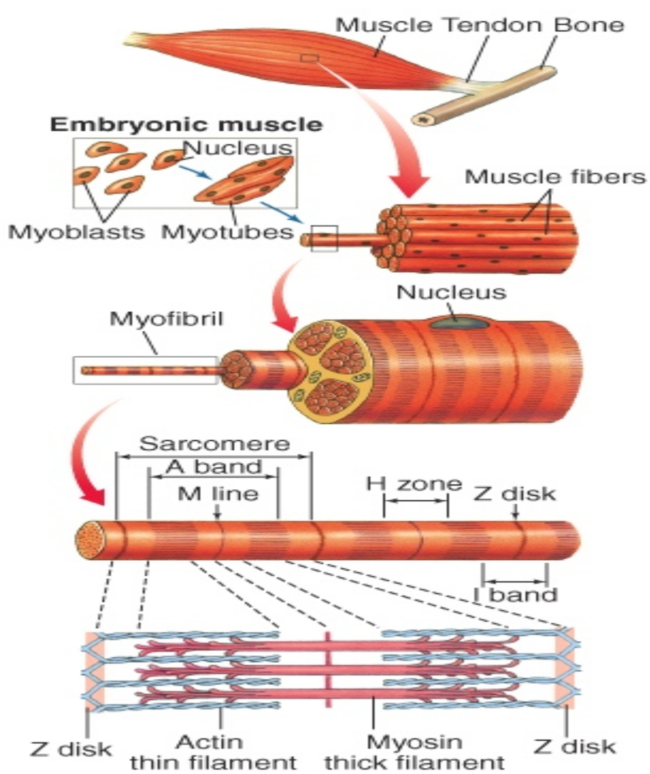
Does Braising Meat Really make it Juicier?

One of the most common cooking myths is that braising meat makes it juicier. After all, braising is a method of cooking meat in a liquid such as stock or wine. It seems common sense to assume that some of the liquid would make its way into the meat as it cooks and make it juicy. Before deciding if this is fact or fiction we need to examine the structure of meat, and what makes it juicy or dry when it is cooked by different methods.

Meat is the muscle tissue of an animal. It is composed primarily of muscle fibers, connective tissue, fat, and water. The first two are proteins. The dominant proteins in muscle fibers are *actin* and *myosin*, while the primary protein in connective tissue is *collagen*. A deconstructed picture of muscle and its component parts is shown below. Muscle is composed of thousands of muscle fibers each of which is composed of very long individual muscle cells. The muscle fibers are packed into bundles surrounded by connective tissue. Each fiber is composed of hundreds of small tubules called myofibrils made up of bands of proteins called actin (thin filaments) and myosin (thick filaments) that control muscle action. When muscle contracts, the actin and myosin proteins bond together through the formation of chemical cross-links, causing the proteins to move closer together resulting in muscle contraction. When the cross-links are broken the actin and myosin return to their original positions and the muscle relaxes. Actin and myosin are held in position by other proteins called Z-disks.



The meat from animals contains about 75% water by weight. About 80% of this water is contained within the myofibrils in the spaces between the thick and thin filaments (see figure). When meat is cooked to high temperatures (well-done) the myofibrils shrink in diameter, squeezing out some of the water inside the myofibrils. Shrinking actually starts at temperatures as low as 40°C (104°F), with maximal water loss beginning at 60°C (140°F). Muscle fibers have been shown to shrink very rapidly to about half of their original volume when heated to temperatures between 50°C (122°F) and 70°C (158°F). If a piece of meat is cooked and immediately sliced the juice we see running out of the meat is the water that has been squeezed out of the myofibrils into the spaces between muscle fibers, where it is free to escape as soon as the meat is sliced. Active shrinking of myofibrils during cooking is the major cause of water loss in meat.

The ability of meat to hold onto the water within muscle tissue is called its *water holding capacity* (WHC), which determines how much water the meat will retain (or loose) when cooked. Related to the WHC of meat is its ability to absorb water from a brine solution. One of the most important factors determining the WHC of meat is the *pH* of the meat. Since the juiciness of cooked meat is perceived as tenderness, the pH of raw meat is perhaps the single most important factor in determining the eating quality of cooked meat.

Proteins contain electrical charges located on many of the amino acids that link together to form proteins like a long chain of paper clips. The electrical charge on different regions of a protein greatly affects how it interacts with its neighboring proteins. The electrical charge is directly influenced by the pH of the environment surrounding the protein. In an acid environment the protein acquires additional positive electrical charges, while in an alkaline environment it acquires additional negative electrical charges. At a pH called the *isoelectric point* all of the positive and negative electrical charges on a group of neighboring proteins are completely balanced so the proteins are electrically neutral. At this pH there is no repulsion between proteins so all of the proteins can cluster together like a crowd of people. When muscle proteins pack together this tightly there is little room for water inside the myofibrils. In addition, tightly packed muscle fibers are difficult to bite through. Thus, when the pH of meat is at its isoelectric point it will be very tough and dry when cooked.

The isoelectric point of most meat such as beef and pork is about pH 5.2, or mildly acidic. As the pH rises and becomes less acidic the muscle proteins acquire additional negative electrical charges that force the proteins apart (like charges repel each other) creating more space for water and making the muscle fiber easier to bite through. The quality of lean pork is strongly influenced by the pH of the meat. To be tender and juicy pork should have pH of 6.5 or higher. Fortunately, it is relatively easy to judge the pH of pork, as darker pork has a higher pH. Select pork that is relatively dark and well marbled with fat, and cook it to the new USDA guidelines of 145°F at the thickest part of the meat. The center should still be pink. Beef tends to be more acidic, around pH 5.5-6.0. But since a whole cut of beef is sterile inside it can be cooked to 125°-130°F without danger of food poisoning. As we will see, a lower internal temperature results in more tender juicy meat. Before I finally answer the original question about braising meat and juiciness, let me just add that the pH of meat is largely dependent on how the animal was treated shortly before slaughter. The more stressed the animal is the more lactic acid that builds up in the muscle tissue following slaughter, thus lowering the pH of the meat. More stress = more acid = lower pH.

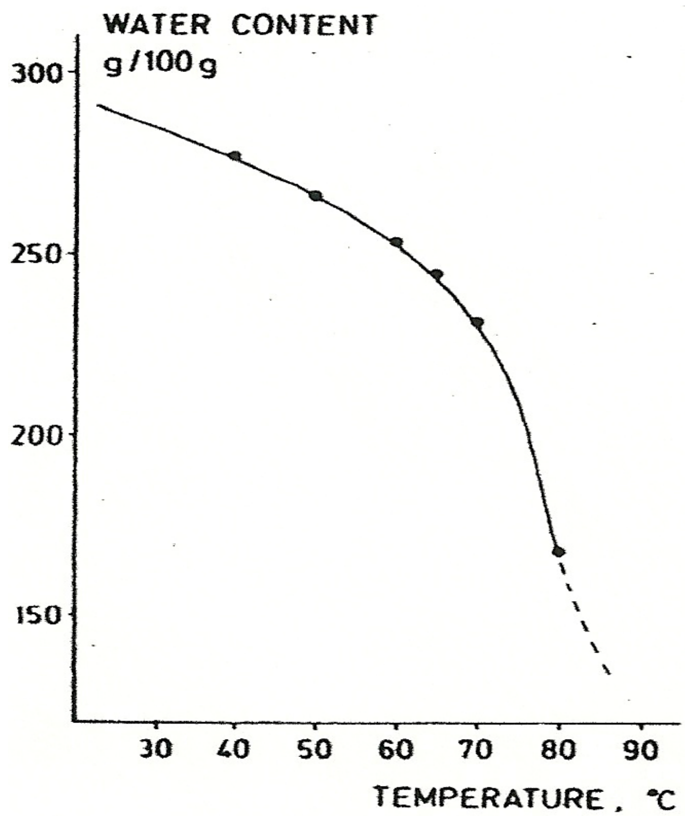
So, does braising meat make it juicier? The answer is NO! At a given pH of the meat the amount of water retained in cooked meat is directly related to the temperature of the meat, and not how it was cooked. This is because the temperature of the meat determines how much the muscle fibers shrink, how much water they can hold, and how tender the meat will be. The research supporting this conclusion goes back forty years. Several research papers published in the Journal of Food Science, Journal of Animal Science, and Meat Science (see references) in the 1970's and early 1980's support this conclusion. It is surprising the myth that braising meat makes it juicier has lasted this long.

The table below summarizes the results published in the Journal of Food Science (1974) that compared "cooking loses" in braised and roasted beef steaks cut to a thickness of 2.5 centimeters from the same cut of eye of the round beef. Both braised and roasted meats were cooked to the same internal temperature of 70°C (158°F). The oven temperature for roasting the meat was 163°C (325°F). Water was used as the braising liquid.

Measure	Braised	Roasted
% Total Cooking Loss	29.58	28.20
% Drip Loss	20.02	5.62
% Evaporation	9.57	22.58

Notice the amount of water lost (and a small amount of fat) was essentially the same for both dry and wet cooking methods. But interestingly, the way the water was lost was different. Most of the water lost during braising was by "drip loss", while most of the water lost by roasting was by evaporation, which seems quite logical. **It is very clear that braising meat in liquid does not make it juicier.**

The graph below published in Meat Science (1983) shows the clear relationship between water loss and the internal temperature of the meat. The vertical axis shows the grams of water retained in meat relative to 100 grams of "fat-free dry meat", while the horizontal axis shows the internal temperature of the meat. Clearly, as the internal temperature of the meat increases the amount of water retained in the meat decreases as the muscle fibers shrink in response to the temperature. This same paper showed that most of the water lost at any given temperature is lost within the first five minutes following attainment of the final temperature.



Helpful Information Sources

1) Bendal, J.R. and D.J. Restall, The Cooking of Single Microfibers, Small Microfiber Bundles and Muscle Strips from Beef Muscles at Varying Heating Rates and Temperatures. Meat Sci. 1983; 8:93-117.
2) Bengtsson, N. E., B. Jakobsson, and M. Dagerskog, Cooking of Beef by Oven Roasting: A Study of Heat and Mass Transfer. J. Food Sci. 1976; 41:1047-1053.
3) Cross, H. R., M. S. Stanfield, and E. J. Koch, Beef Palatability as Affected by Cooking Rate and Final Internal Temperature. J. Anim. Sci. 1976; 43:114-121.
4) McCrae, S.E., and P.C. Paul, The Rate of Heating as it Affects the Solubilization of Beef Muscle Collagen. J. Food Sci. 1974; 39:18-21.
5) Offer, G. and J. Trinick, On the Mechanism of Water Holding in Meat: The Swelling and Shrinking of Myofibriles. Meat Sci., 1983; 8:245-281.
6) Schock, D.R., D. L. Harrison, and L.L. Anderson, Affect of Dry and Moist Heat Treatments on Selected Beef Quality Factors. J. Food Sci., 1970; 35:195-198.
7) Van Laack, R. L., S. G. Stevens, and K.J. Stadler, The Influence of Ultimate pH and Intramuscular Fat Content on Pork Tenderness and Tenderization. J. Anim. Sci., 2001; 79:392-397.
8) Warriss, P. D., Meat Science: An Introductory Text, CABI Publishing, 2000.