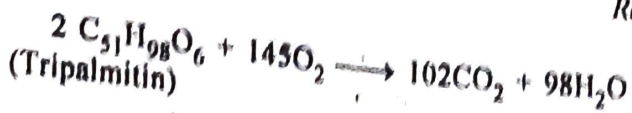


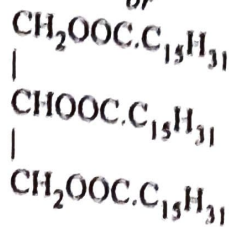
RESPIRATORY QUOTIENT

Respiratory Quotient (RQ) may be defined as "*the ratio between the volume of carbon dioxide given out and oxygen taken in simultaneously by a given weight of the tissue in a given period of time at standard temperature and pressure.*"

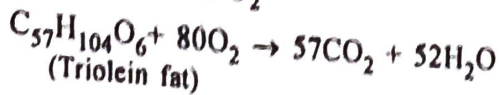
$$\text{Respiratory Quotient} = \frac{\text{Volume of CO}_2 \text{ evolved}}{\text{Volume of O}_2 \text{ absorbed}}$$



or

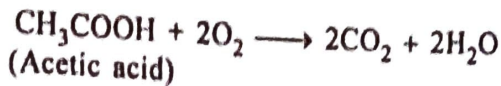


$$\text{RQ} = \frac{\text{CO}_2}{\text{O}_2} = \frac{102 \text{CO}_2}{145 \text{O}_2} = 0.7$$



$$\text{RQ} = \frac{\text{CO}_2}{\text{O}_2} = \frac{57 \text{CO}_2}{80 \text{O}_2} = 0.7$$

However, simple fatty acids such as acetic acid liberate equal amount of CO_2 and in such cases RQ is unity.



$$\text{RQ} = \frac{\text{CO}_2}{\text{O}_2} = \frac{2 \text{CO}_2}{2\text{O}_2} = 1 \text{ or unity}$$

It is quite interesting to note that fats liberate more energy than carbohydrates. A gram of carbohydrate yields 3.8 kcal, while a similar amount of fat produces about 9.1 kcal. May be this is the reason why fats are common reserve food materials in seeds.

(3) Respiratory Quotient of Proteins and Derivatives

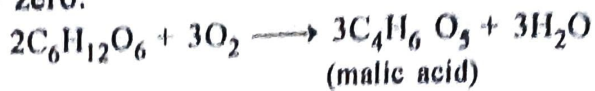
Proteins and amino acid derivatives serve normally as respiratory substrate only in seeds rich in proteins. The normal cells consume protein only during starving conditions. Otherwise, proteins are seldom respired.

Like fats, proteins are also compounds with lesser oxygen as compared to carbohydrates and the proportion of oxygen to carbon is invariably low. Proteins rarely serve as respiratory substrates but when they do serve their hydrolysis products require more oxygen for complete oxidation as a result of which, the value of RQ falls to less than unity. The RQ value of proteins fluctuates around 0.79. During protein oxidation, the value of RQ may be = 1.0(0.99) when ammonia is produced or 0.8 (0.79) when amide formation occurs. When amides are oxidised the RQ value rises above one.

(4) Respiratory Quotient of Succulents

In succulent plants such as *Opuntia* or members of the family *Crassulaceae* and in anthocyanin rich leaves, the complete oxidation of carbohydrate does not occur, as a result of which only intermediate products are formed without the production of CO_2 . At night, when stomata are open in succulent plants, oxygen is absorbed and intermediate compounds are formed due to partial oxidation on account of which there is no evolution of CO_2 and the RQ value is found to be less than

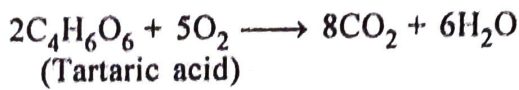
one, mostly zero. In *day time*, when complete oxidation of intermediate acids occurs the CO_2 produced is used up in photosynthesis with the result that there is no evolution of CO_2 and RQ falls to zero.



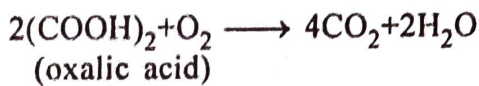
$$\text{RQ} = \frac{\text{CO}_2}{\text{O}_2} = \frac{0}{3} = \text{Zero}$$

(5) Respiratory Quotient of Organic Acids

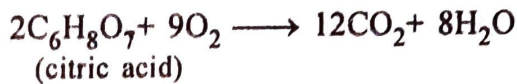
Organic acids are rich in oxygen and the proportion of oxygen to carbon is very high. When organic acids are used as respiratory substrate lesser oxygen is needed to be absorbed and more CO_2 is evolved with the result that RQ value is found to be more than unity.



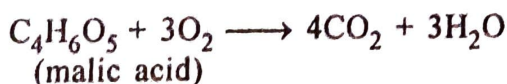
$$\text{RQ} = \frac{\text{CO}_2}{\text{O}_2} = \frac{8\text{CO}_2}{5\text{O}_2} = 1.6$$



$$\text{RQ} = \frac{\text{CO}_2}{\text{O}_2} = \frac{4\text{CO}_2}{1\text{O}_2} = 4$$

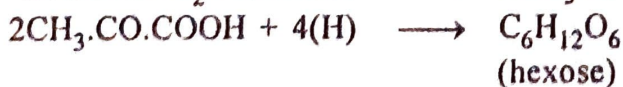


$$\text{RQ} = \frac{\text{CO}_2}{\text{O}_2} = \frac{12\text{CO}_2}{9\text{O}_2} = 1.33$$

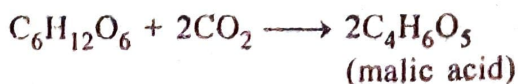


$$\text{RQ} = \frac{\text{CO}_2}{\text{O}_2} = \frac{4\text{CO}_2}{3\text{O}_2} = 1.33$$

Malic acid may also be converted into hexose, with the following intermediate stages. These reactions are popularly known as *Wood-Werkman reaction*.



If this hexose is partly respired, the RQ may increase to 1.33 or more. Sometimes RQ value is found to be 0.2 to 0.3 when the reaction gets associated with a combination of hexose respiration and organic acid synthesis at the expense of CO_2 *i.e.*,



(6) Respiratory Quotient when Oxygen is Utilised for Other Metabolic Processes

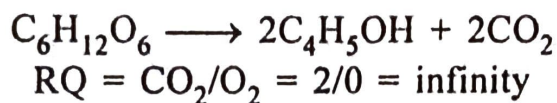
Apart from respiration some other metabolic processes such as synthesis of anthocyanins and conversion of fats to carbohydrates also require oxygen. In such cases the amount of CO_2 evolved does not correspond to the amount of oxygen absorbed and, therefore, the value of RQ falls below unity. In *Bryophyllum*, leaves are capable of utilising CO_2 (liberated during respiration) for synthesizing organic acids in the dark, so the RQ value falls below unity.

(7) Respiratory Quotient of Maturing Fatty Seeds

During the maturation of fatty seeds simple carbohydrates are converted into fats. In the process oxygen is released but it is used up in respiration. As a result CO_2 is released during respiration but oxygen is not absorbed from outside. In such cases the value of RQ is found to be more than unity. But in germinating fatty seeds, RQ value falls below unity because of combined effect of the seed using fat substrate for respiration and also synthesizing carbohydrates from fats.

(8) Respiratory Quotient of Tissue Respiring in Absence of Oxygen

In absence of oxygen (anaerobic respiration) in which CO_2 is evolved without O_2 being absorbed, the RQ value is found to be more than unity.



The following table enumerates RQ values in different plant parts and substrates.

<i>Plants</i>	<i>RQ</i>
1. Leaves rich in carbohydrate.	1
2. Darkened shoots of <i>Opuntia</i> .	0.03
3. Germinating starchy seeds	1
4. Germinating linseed (high fat).	0.64
5. Germinating buckwheat (high protein)	0.5
6. Germinating peas.	1.54-2.4