# MSR (MS for Rooting)

## MSR (MS for Rooting) in Plant Tissue Culture: Origins, Uses, and Formulation

Plant tissue culture relies heavily on carefully formulated media to support the growth and development of plant cells, tissues, and organs *in vitro*. Among the various media employed, MSR (MS for Rooting) stands out as a specialized formulation optimized for inducing root formation. While not as widely known as Murashige and Skoog (MS) medium, its tailored composition makes it a valuable tool in plant biotechnology.

**Origin:**

Unlike MS medium, which has a clearly defined origin with Murashige and Skoog in 1962, the exact origin of MSR is less documented in a single, seminal publication. MSR is not a formally named or standardized medium like MS or B5. Instead, "MSR" is a descriptive term referring to modifications *of* the MS medium specifically designed to promote root development. These modifications typically involve adjustments to the levels of plant growth regulators, primarily auxins and cytokinins, to favor root initiation and elongation. Researchers have independently adapted MS medium for improved rooting in various plant species over the years, leading to a variety of formulations described as ‘MSR’. The common thread is the base of MS medium with targeted changes for rooting efficiency.

**Applications:**

The primary application of MSR media lies in its effectiveness in inducing root formation in plant tissue culture. This is crucial for various downstream applications including:

- **Micropropagation:** After shoot multiplication, MSR is frequently used to root the newly generated plantlets before transplanting them *ex vivo*.
- **Woody Plant Regeneration:** Many woody plants are recalcitrant to propagation through conventional methods. Modified MS media (MSR) often play a vital role in successfully rooting stem cuttings or tissue-cultured shoots of these species.
- **Clonal propagation:** Maintaining genetic uniformity in valuable plant lines is facilitated by the efficient rooting of micropropagated shoots on MSR.

Specific plant species showing success with MSR formulations include various fruit trees (apples, pears, citrus), ornamental plants, and medicinal herbs. The exact formulation for optimization often needs species-specific adjustments. While generalizations are difficult, certain plant families or genera seem to respond positively to MSR modifications of the MS medium. For example, success with MSR variations has been reported in several studies focusing on *Eucalyptus* species regeneration.

**Formulation:**

A precise, universally accepted MSR formulation doesn’t exist. The term encompasses various adaptations of the basic MS

medium. However, a representative formulation, based on common modifications, is outlined below. Concentrations might vary slightly depending on the specific plant species and desired outcome:

| Component | Concentration (mg/L) | Role |
|---|---|---|
| Macronutrients | | |
| $NH_4NO_3$ | 1650 | Nitrogen source |
| $KNO_3$ | 1900 | Nitrogen and potassium source |
| $CaCl_2 \cdot 2H_2O$ | 440 | Calcium source |
| $MgSO_4 \cdot 7H_2O$ | 370 | Magnesium and sulfur source |
| $KH_2PO_4$ | 170 | Phosphate source |
| Micronutrients | | |
| $FeSO_4 \cdot 7H_2O$ | 27.8 | Iron source |
| $MnSO_4 \cdot 4H_2O$ | 22.3 | Manganese source |
| $ZnSO_4 \cdot 7H_2O$ | 8.6 | Zinc source |
| KI | 0.83 | Iodine source |
| $H_3BO_3$ | 6.2 | Boron source |
| $Na_2MoO_4 \cdot 2H_2O$ | 0.25 | Molybdenum source |
| $CuSO_4 \cdot 5H_2O$ | 0.025 | Copper source |
| $CoCl_2 \cdot 6H_2O$ | 0.025 | Cobalt source |
| Vitamins | | |
| Thiamine HCl | 1 | Vitamin B1 |
| Pyridoxine HCl | 1 | Vitamin B6 |
| Nicotinic acid | 1 | Vitamin B3 |
| Myo-inositol | 100 | Growth factor |
| Growth Regulators | | |

| Component | Concentration (mg/L) | Role |
|---|---|---|
| IBA (Indole-3-butyric acid) | 0.5-5 | Auxin, promotes root formation |
| NAA (1-Naphthaleneacetic acid) | 0.1-2 | Auxin, promotes root formation |
| Sucrose | 30000 | Carbon source |
| Agar-agar | 7-8 g/L | Gelling agent |

**Common Modifications:** The concentration of auxins (IBA or NAA) is the most frequent modification. Higher concentrations generally promote root formation; lower concentrations, when combined with appropriate cytokinins, can stimulate shoot development. The addition of activated charcoal can improve the rooting response in some species by adsorbing inhibitory compounds from the plant explant.

**Conclusion:**

MSR media, though not a formally defined medium, represents a practical and widely utilized approach to enhance root formation in plant tissue culture. Its strengths lie in its adaptability to diverse plant species and its relative simplicity compared to other specialized media. However, limitations exist—optimal hormone concentrations need careful determination for each species and even genotype. The stability of auxins within the MSR medium can also be an issue.

Compared to MS medium, MSR focuses on root development, whereas MS serves as a more general-purpose basal medium for a wide spectrum of plant tissue culture applications, often requiring further supplementation of growth regulators according to the target purpose. B5 medium (Gamborg, 1968) is another widely used basal medium, sometimes also optimized for

rooting, but may have different strengths and weaknesses compared with MS-based MSR formulations. Despite the lack of a formally defined MSR, the concept of modifying a basal medium like MS to enhance rooting efficiency will likely remain a cornerstone in plant tissue culture techniques for the foreseeable future.