International Journal of
Global Multidisciplinary Research and Analytics

IJGMRA | ISSN (Online): 3107-6483
October-December 2025 | Vol. 01 | Issue 3

Website: www.thearyapublication.com

Characterization and Extraction of Ethyl Alcohol from Variety of Potatoes

Dr. Vijai Kumar Pandey*

*Assistant professor, department of chemistry, maharaj singh college, Saharanpur
Email: VijayPandey0654@gmail.com
DOI: doi.org/10.5281/zenodo.18205070
Accepted on: 29/12/2025 Published on: 10/01/2026

Abstract:

Ethyl alcohol is extracted from various potato varieties (red potatoes, white potatoes, and waste potatoes) through fermentation using Saccharomyces cerevisiae and characterized via distillation. Potatoes were processed by cutting, crushing, and drying at 85°C, then milled to 2 mm particle size. The potato slurry was liquefaction with alpha-amylase at 80°C for 40–45 minutes, followed by saccharification with glucoamylase at 60–65°C for several hours. Fermentation occurred in sealed vessels at 25–35°C with pH 4–6 for 1–3 days at approximately 20% (w/v) concentration. Ethyl alcohol was separated via distillation at 80°C.

Keywords: *White and red potatoes, waste potato, ethyl alcohol, saccharomyces cerevisiae, alpha amylase, glucoamylase, fermentation, distillation.*

Introduction:

Over 5,000 varieties of potatoes exist globally, with India producing more than 80 varieties. Uttar Pradesh is a major potato-producing state, particularly in the Agra district, which is the largest potato-producing region in the country [1]. Potatoes available in Saharanpur wholesale markets include red and white varieties, distinguished by their texture, moisture, and starch content [2][3].

Potato Composition and Classification:

White Potatoes: Starchier and denser, better suited for frying, baking, mashing, and roasting. These varieties contain 16–20% starch content.

Red Potatoes: Waxy, less starchy, and sugarier. These are better for boiling, grilling, and steaming, with starch content ranging from 14–16%.

Chemical Composition of Potatoes

- **Starch:** 16–20%

- **Protein:** 2–2.5%
- **Fibre:** 1–1.8%
- **Fatty acids:** 0.15%

Potatoes and waste potatoes are rich sources of starch, which is utilized for ethyl alcohol production as an alternative energy source to petroleum. The starch content varies by potato variety (14–22%), with floury potatoes containing more starch than red varieties. Older potatoes contain more starch than newer ones [2][6].

Research Objectives:

This study investigates the characterization of ethyl alcohol extracted from potatoes and waste potatoes, utilizing waste potatoes as raw material. The primary objectives are:

1. Extract ethyl alcohol via simple distillation processes
2. Characterize ethyl alcohol chemically
3. Quantify the amount of ethyl alcohol produced from different potato varieties

2. Materials and Methods

2.1 Materials Required

- Plastic bags for keeping potatoes
- Knife for cutting and crushing potatoes
- Water boiling bath
- Oven (80–85°C capacity)
- Crusher/mill
- Sieves (2 mm mesh size)
- Balance (analytical)
- Graduated cylinder
- Distillation apparatus
- Conical flask
- *Saccharomyces cerevisiae* yeast
- Alpha-amylase enzyme
- Glucoamylase enzyme
- Distilled Water

2.2 Experimental Procedure

Sample Preparation

Potatoes were obtained from local wholesalers in Saharanpur, and waste potatoes were collected from shops and restaurants. The general experimental procedure involved:

1. **Peeling:** Potatoes were peeled using a knife
2. **Washing and Cutting:** Potatoes were washed and cut into small pieces
3. **Boiling:** Pieces were boiled to soften
4. **Crushing:** Boiled potatoes were crushed to a particle size of 2 mm
5. **Drying:** Crushed samples were dried in an oven at 85°C for one day

Enzymatic Liquefaction and Saccharification

Red and white potatoes were milled separately. Potato slurry was prepared with the following protocol:

1. **Liquefaction:** Slurry was treated with alpha-amylase enzyme at 80°C for 40–45 minutes to hydrolyze starch into simpler sugars
2. **Cooling:** The sample was cooled to room temperature
3. **Saccharification:** Glucoamylase enzyme was added at 60–65°C for several hours to further break down starch polymers into glucose

Fermentation

The enzymatically treated solution was fermented with *Saccharomyces cerevisiae* yeast under the following conditions:

- **Temperature:** 25–35°C
- **pH Range:** 4–6
- **Concentration:** Approximately 20% (w/v) potato slurry
- **Fermentation Period:** 1–3 days in sealed vessels

Distillation

Ethyl alcohol was separated from the clear fermented solution via distillation at 80°C, exploiting the different boiling points of water (100°C) and ethanol (78.4°C). The distillate was collected in graduated cylinders.

Chemical Characterization

The extracted ethyl alcohol was characterized by:

- **Odor Test:** Confirming the characteristic odor of ethanol
- **Flammability Test:** Demonstrating combustibility

- **Oxidation Test:** Decolorizing acidified $K_2Cr_2O_7$ solution, confirming the presence of primary alcohol [2][3][6][8][11]

3. Results

3.1 Ethanol Yield Data

The distillation process yielded the following volumes of ethyl alcohol from each potato variety:

Table 1: Ethanol yield (mL) from different potato varieties over fermentation periods

Fermentation Period (days)	Red Pot (mL)	WhitePot (mL)	Waste Pot (mL)
1	30.0	31.0	28.0
2	40.0	42.0	30.0
3	35.0	36.0	25.0
4	34.0	35.0	20.0
5	35.0	36.0	20.0
6	34.0	34.0	20.0

Table 1: Ethanol Production from Potato Varieties

The data demonstrate that:

- **Maximum yield** occurs on day 2: Red potato (40 mL), White potato (42 mL), Waste potato (30 mL)
- **Trend:** Ethanol production increases from day 1 to day 2, then gradually decreases through day 6
- **Variety Performance:** White potatoes show the highest peak yield, followed closely by red potatoes; waste potatoes consistently produce lower yields
- **Plateau Effect:** From day 4 onwards, ethanol production stabilizes at lower levels (20–35 mL)

3.2 Graphical Analysis

The following graph illustrates ethanol concentration against fermentation period:

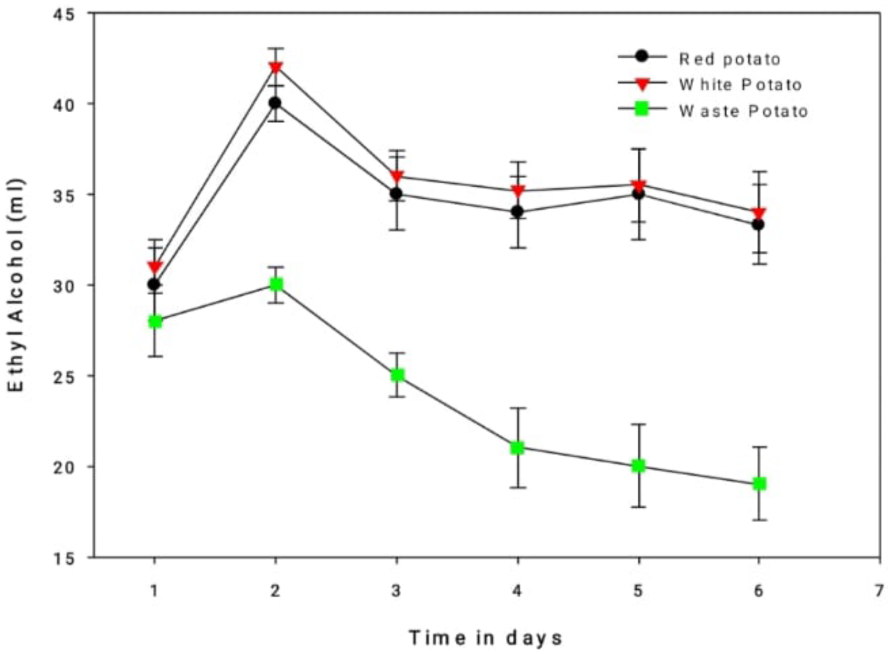

Figure 1: Ethanol concentration (mL) versus fermentation period (days) for three potato varieties. Red potatoes and white potatoes show similar yield profiles with peak production on day 2, while waste potatoes consistently show lower yields with a plateau beginning on day 4.

The graph reveals:

- **Red and White Potatoes:** Nearly parallel trajectories due to similarity in starch content and composition
- **Peak Production:** Both red and white potatoes reach maximum ethanol concentration (~40–42 mL) on day 2
- **Waste Potatoes:** Form the lower trajectory with peak of ~30 mL on day 2
- **Post-Peak Decline:** All varieties show reduced ethanol concentration from day 3 onwards, indicating substrate depletion and yeast stress

3.3 Distillation Apparatus

The experimental setup for ethanol distillation is shown below:

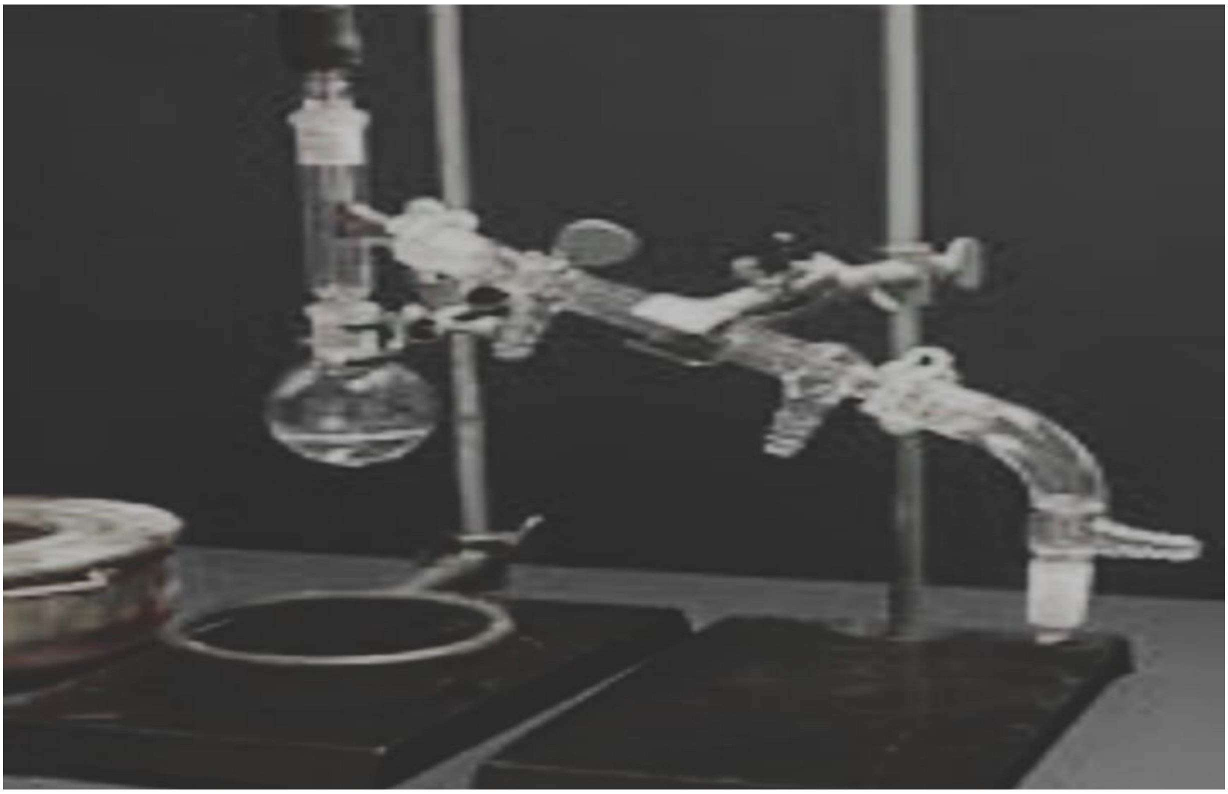

Figure 1. Distillation apparatus used for separation of ethyl alcohol from fermented potato slurry.

Figure 2: Laboratory distillation apparatus used for ethanol separation from fermented potato slurry. The apparatus includes a conical flask containing the fermented solution, heating element, condenser, and collection vessel for the distillate.

4. Discussion

Different parameters significantly affect ethyl alcohol production, including sample concentration, fermentation duration, temperature, and pH value. This study reveals several important findings:

4.1 Effect of Sample Concentration

As potato slurry concentration increases, ethanol production increases correspondingly. At approximately 20% (w/v) concentration, optimal fermentation and alcohol yield were observed. Higher concentrations may inhibit yeast activity due to osmotic stress, while lower concentrations provide insufficient substrate for maximum alcohol production [2][3][5][6].

4.2 Effect of Fermentation Duration

A critical observation is the biphasic pattern of ethanol production:

- **Phase 1 (Days 1–2):** Rapid increase in ethanol production as yeast actively metabolizes glucose from starch hydrolysis
- **Phase 2 (Days 3–6):** Gradual decline in ethanol concentration due to:
    - Substrate depletion (glucose exhaustion)
    - Accumulation of ethanol, which inhibits yeast activity at concentrations >15% (v/v)
    - Accumulation of other fermentation byproducts

4.3 Optimal Temperature and pH

Yeast fermentation at elevated temperatures (25–35°C) proved ideal for ethanol production. The optimum temperature range for *Saccharomyces cerevisiae* fermentation is 25–35°C with a pH range of 4–6. When pH exceeds 6, ethanol concentration decreases significantly, indicating suboptimal yeast activity and reduced enzyme function [1][3][6][8].

4.4 Comparison Among Potato Varieties

White Potatoes vs. Red Potatoes: Red potatoes yielded slightly lower peak ethanol (40 mL) compared to white potatoes (42 mL), contrary to typical starch content expectations. This discrepancy may be attributed to:

- Differences in glucose release kinetics during enzymatic hydrolysis
- Variations in yeast fermentation efficiency
- Differences in sugar composition beyond simple starch content

Waste Potatoes: Consistently produced lower ethanol yields (~30 mL peak) compared to fresh potatoes. This reduction may result from:

- Degradation of starch content during storage
- Possible contamination or fungal growth
- Lower initial enzyme availability for hydrolysis
- Reduced yeast viability in suboptimal substrate conditions

Despite lower yields, waste potatoes remain viable for ethanol production, supporting the sustainability objective of utilizing agricultural byproducts [8][9][10][11].

4.5 Chemical Characterization Results

The extracted ethanol was confirmed to be ethyl alcohol through:

- **Odor:** Characteristic pungent, sweet aroma typical of ethanol
- **Flammability:** Rapid combustion with blue flame
- **Oxidation:** Decolorization of acidified $K_2Cr_2O_7$ solution from orange to green, confirming primary alcohol oxidation to acetaldehyde [2][3][6][8][11]

It's also confirmed by iodoform test.

5. Conclusion

This research successfully demonstrated the extraction and quantification of ethyl alcohol from different potato varieties through enzymatic hydrolysis and yeast fermentation. Key findings include:

1. **Optimal Yield:** White potatoes showed the highest peak ethanol production (42 mL on day 2) at 20% (w/v) concentration
2. **Fermentation Kinetics:** Ethanol production follows a biphasic pattern with maximum yield on day 2, followed by gradual decline
3. **Environmental Sustainability:** Waste potatoes, while producing lower yields, can be effectively utilized for bioethanol production
4. **Process Parameters:** Temperature (25–35°C) and pH (4–6) significantly influence yeast fermentation efficiency
5. **Chemical Verification:** The product was confirmed as ethyl alcohol through physical and chemical tests

The practical application of this process could contribute to sustainable biofuel production and waste utilization in regions with significant potato cultivation. Future studies should investigate the optimization of enzyme dosage, pH buffering systems, and yeast strain selection to maximize ethanol yield from waste potatoes.

References:

[1] Rani P., Garg FC., Sharma SS., and Watil. (2009). Ethanol production from potato. *Indian Food*, 63(4), 63–68.

[2] Joginder S., Duban, Ashok Kumar, and Sunil Kr. Tanwar. (2013). Bioethanol production from starchy part of potato using yeast (*Saccharomyces cerevisiae*) MTCC-1. *African Journal of Microbiology Research*, 7(46), 5253–5260.

[3] A. Ganguly, P. Banerjee, and P.K. Chatterjee. (2017). Production of ethanol from waste potato using locally biocatalyst conference paper. *Conference Proceedings*, 143–151.

[4] Meenakshi A., and Kumaresan R. (2014). Ethanol production from corn, potato and its process development. *International Journal of Chemistry and Technology Research*, 6(5), 2843–2853.

[5] Rani P., Sharma S., Garg C., Kushal Raj, and Neelam Wati. (2010). Ethanol production from potato flour by *Saccharomyces cerevisiae*. *Indian Journal of Science and Technology*, 3(7), 733–736.

[6] Ramesh C. Ray, and Samir K. Naskar. (2023). Dynamic biochemistry process biotechnology and molecular biology: Bio ethanol production from sweet potato by enzymatic liquefaction and simultaneous saccharification and fermentation (SSF) process.

[7] Narde A. (2009). Distilleries in India. In *Sugar India Year Book 09* (ed. Ajit Narde). Anekant Prakashan Kolhapur, pp. 401–432.

[8] Kilpimaa S., Kuokkanen T., and Lassi V. (2009). Bioethanol production from waste potatoes.

[9] Mohamad Jaber Noufal, Baizhan Li, and Zena Ali Mallia. (2017). Production of bio-ethanol from waste potatoes. *Earth and Environmental Science*.

[10] Sudhir Kumar Rai, L.P.S Raj Put, and Yogendra Singh Arkeerti Tantwal. (2013). Study on bio ethanol production from waste potatoes using yeast (*S. cerevisiae*). *Plant Archives*, 13, 847–853.

[11] Open Access Journal of Chemistry, Vol. 2, Issue 2. (2018), pp. 17–24.