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**Study on processing conditions and functional  
properties of Japanese green tea**

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## Abstract

Green tea is rich in antioxidants and plays an important role in the prevention of some diseases, and it has become one of the most popular beverages in many countries. Green tea leaves harvested several times a year in Japan and are manufactured by multiple processing steps, which are mainly divided into six unique process: steaming, primary rolling, rolling, secondary rolling, final rolling, and final drying. The differences in chemical composition among green tea products are generally attributable to different conditions of growth and processing. This study aims to investigate the impact of harvest seasons (1st, 2nd and 3rd) and various processing conditions (manufacturing system scale and rolling time ) on the functional quality of Japanese green tea. Morphology and microstructure of tea leaves were observed as well as total polyphenol content (TPC) and total antioxidant activity antioxidant activity (DPPH-radical scavenging ability and ferric reducing antioxidant power (FRAP)) were evaluated in tea leaves and infusions during processing. The green tea leaves were manufactured using various scale manufacturing systems of which capacity for raw leaf treatment were 15, 60 and 120 kg. Additionally, tea samples harvested in different seasons were produced by different rolling time (15, 30 and 60 min). Bioactive compounds (total polyphenol content (TPC), total flavonoid content (TFC)) and antioxidant activity (DPPH and FRAP)) were evaluated in dried tea leaves and tea infusions, and in tea infusions during vitro gastrointestinal digestion. The results showed that intensified manufactured process resulted in the increase of the dissolution of bioactive compounds and antioxidant activity from samples. Reducing the raw fresh tea leaf input amount can significantly affect the extractability of chemical components from green tea, thereby increasing the production utilization rate of green tea. The values of bioactive compounds and antioxidant activity in tea infusions were decreased throughout digestion. Furthermore, these values remained stable throughout the digestion stage of gastric and small intestine respectively, and showed obvious values change while the small intestine digestion started due to the changes of pH and digestive enzymes. In addition, bioactive compounds and antioxidant property of the 2nd flush tea leaf were higher than those of the 1st and 3rd flush. These results indicate that harvest season and processing conditions affect the ability of the antioxidants in the samples to withstand digestion.

## Abstract (Japanese)

緑茶は抗酸化物質が豊富、慢性疾患の予防に重要な役割を果たしており、多くの国で最も人気のある飲料の1つになっている。機械製茶による煎茶の製造工程は、基本的に、蒸熱、粗揉、揉捻、中揉、精揉、および乾燥の6操作で構成される。それら操作の条件を精密に調整することで、最終製品となる煎茶茶葉の品質向上が図られている。緑茶製品間の化学組成の違いは、一般的に茶葉の主産地と加工の異なる条件に起因する。本研究は、収穫期（一番、二番および三番茶）および加工条件（製造システム規模および揉捻時間）が日本緑茶の機能品質に及ぼす影響を調査することを目的としている。茶葉の形態と微細構造を観察し、総ポリフェノール含有量（TPC）と総抗酸化活性抗酸化活性（DPPH-ラジカル捕捉能と鉄還元抗酸化力（FRAP））を茶葉と抽出液で評価した。また、サンプルは生葉処理能力が15、60、120kgの各規模の製造システムにより製造され、さらに各季節に収穫された茶葉を揉捻時間（15、30、60分間）によって加工された。生産加工された茶葉の生物活性化合物（TPC）および抗酸化活性（DPPH、FRAP）を評価し、そして、*in vitro*人工消化実験における緑茶の生物活性化合物および抗酸化性の変化も調べた。異なる消化処理時間で消化液を抽出し、生物活性化合物の含有量抗酸化性を測定した。強化された製造プロセスが、サンプルからの生物活性化合物の溶解および抗酸化活性の増加をもたらしたことを示した。茶浸出液における生物活性化合物と抗酸化活性は、人工体外消化を通して減少した。一方ですべてのサンプルの抗酸化性は胃と小腸の消化段階を通して安定しており、pHと消化酵素の変化により小腸の消化が始まる間に明らかな値の変化を示した。また2番茶の茶葉の生物活性化合物と抗酸化特性は、1と3番茶より高くなることが明らかになった。したがって、収穫期と加工条件がサンプル中の抗酸化物質の消化に耐える能力に影響を与えることを示唆している。