We introduce a highly compact fiber-optic Fabry-Pérot refractive index sensor integrated with a fluid channel that is fabricated directly near the tip of a 32 μm in diameter single-mode fiber taper. The focused ion beam technique is used to efficiently mill the microcavity from the fiber side and finely polish the end facets of the cavity with high spatial resolution. It is found that a fringe visibility of over 15 dB can be achieved and that the sensor has a sensitivity of ∼1731 nm/RIU (refractive index units) and a detection limit of ∼5.78 × 10⁻⁶ RIU. This miniature integrated all-in-fiber optofludic sensor may find use in minimal-invasive biomedical applications.